1997

Cooperative learning with interactive multimedia: the effect of gender and group composition on attitude and interaction

Jane Mason Adamson
Iowa State University

Cooperative learning with interactive multimedia:
The effect of gender and group composition
on attitude and interaction

by

Jane Mason Adamson

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Education (Curriculum and Instructional Technology)

Major Professors: Donald A. Rieck and Ann D. Thompson

Iowa State University

Ames, Iowa

1997

UMI Number: 9725387

Graduate College
Iowa State University

This is to certify that the Doctoral thesis of

Jane Mason Adamson

has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Co-major Professor

Signature was redacted for privacy.

Co-major Professor

Signature was redacted for privacy.

For the Major Program

Signature was redacted for privacy.

For the Graduate College

DEDICATION

The completion of this dissertation is dedicated to my family - Rich, Scott, Kathryn, and Grace - who have been wonderfully patient and encouraging. Thank you from my heart.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study investigated the effect of gender and group gender composition on interaction patterns and attitudes toward their cooperative learning experience of seventh- and eighth-grade students working with the multimedia program *Loess Hills Interactive*. One hundred twenty-seven middle school science students (60 males, 67 females) from two schools in Iowa participated in the month-long study. Students were randomly assigned to cooperative learning groups of 3, 4, and 5 with the following gender compositions: (1) same-gender, (2) mostly-male; (3) mostly-female, and (4) equal-gender. Trained raters coded and tallied interaction frequencies for each student from videotapes, using a Peer Interaction Scale developed from pilot study data. The interaction categories included: (a) path/pace, (b) task, (c) socio-emotional, (d) technical, (e) off-task, and (f) uncodable. An attitudinal survey, administered at the end of the four weeks, measured five factors: (1) positive emotional reaction to the group, (2) presence of helping behaviors in the group, (3) preference for working alone, (4) lack of helping behaviors in the group, and (5) preference for small-group learning.

Two-way analyses of variance were performed on the verbal interaction and attitudinal data to determine if significant differences occurred between males and females in groups of varying gender composition. Student gender did not have a significant effect on either interactions or attitude. However, when group and school were the independent variables in two-way analyses of variance, significant effects were found for group composition on three peer interaction categories (total, path/pace, and task) and for school on five categories (total, path/pace, task, socio-emotional, and off-task). Students in mostly-female

groups scored significantly higher than mostly-male or equal-gender groups in their preference for small-group learning. Pearson product-moment correlations determined that no significant correlations occurred between the interaction and attitudinal data. Differences in students, teacher involvement, and implementation between the two schools may have influenced interaction and attitudinal data.

CHAPTER I. INTRODUCTION

Within the past decade the development of interactive multimedia technology has generated new learning experiences for middle school students. Interactivity refers to the responsiveness of the media to user control (Heinich, Molenda, & Russell, 1989). Examples of interactive technologies used in the classroom include CD-ROM (CD-i), hypermedia, computer-based instruction (CBI), and 2-way television (Gayeski, 1992; Thompson, Simonson, & Hargrave, 1992; U. S. Congress, 1988). Interactive television (i-TV) is a recently developed innovative platform to deliver multimedia classroom instruction. Using i-TV, students access a multi-user computer program stored on a server at another location.

When students in cooperative learning groups use interactive multimedia, they benefit from the instructional effectiveness of both the technology and cooperative learning environment (Jernstedt, 1983; Johnson & Johnson, 1986). Educational technology motivates students by offering learning experiences beyond the limitations of textbooks (Dede, 1987, 1989). In general, cooperative learning promotes student self-esteem, achievement, and positive attitudes toward peers and school (Adams & Hamm, 1996; Johnson & Johnson, 1989; Slavin, 1995). The following factors influence the decision to use technology in a group or individually: (a) number of available work stations, (b) program design, and (c) the teacher's preference for cooperative or individual learning.

Both interactive technology and cooperative learning facilitate involvement by students in the learning process. Working with interactive programs encourages active engagement in educational activities (Dalton, 1986;

Lucas, 1992; Weller, 1988). Interactive technology requires students to make decisions and responses while working with the program. Cooperative learning requires students to communicate with each other to accomplish the task. The degree of student involvement during learning is critical to the quality of the learning (Jernstedt, 1983).

Constructivism is a current model of understanding learning which emphasizes the importance of the active involvement of the learner with the learning process (Cooper, 1993; Seels, 1989). The constructivist perspective views knowledge and understanding to be individually constructed based on one's experiences (Duffy & Jonassen, 1992). Inquiry-guided, collaborative, and learner-centered teaching strategies support the constructivist model. The use of interactive multimedia by cooperative groups of students to conduct investigations and create a project follows constructivist approaches to designing learning activities. Using technology, students can access a wide range of information during investigative activities and develop multimedia presentations.

Peer interaction and student attitudes during a learning activity influence the quality of the learning during cooperative learning. Peer verbal interaction, which occurs among students as they complete a learning activity, is related to achievement (McCombs, 1985; Webb, 1985). The presence of giving and receiving explanations or not receiving needed explanations during group work was linked to achievement scores for students completing traditional classroom math lessons (Webb, 1982a, 1984; Webb and Cullian, 1983). Students who received or gave explanations scored higher on achievement measures. Those who did not receive needed explanations scored lower. Peer interaction among students working with technology-based lessons was investigated (Hooper, 1992b;

Lee, 1993; Simsek, 1993). Technology-based research findings also reported a relationship between achievement and giving and receiving explanations and not receiving explanations.

Student perceptions and attitudes influence learning. Students who perceive peer support learn more than those who do not perceive a positive group atmosphere. Students who experience high-quality cooperative experiences, defined by perception of peer concern and friendliness, tend to score higher on measures of achievement than those with low-quality experiences (Battistich, Solomon, & Delucchi, 1993).

This study examines the effect of gender and gender group composition on peer interaction and attitudes of students using the interactive multimedia program *Loess Hills Interactive*. Development of the i-TV program was through a collaborative effort by three Iowa-based corporations: Iowa Public Television (IPTV), Interactive Resources (IR), and Wallace Technology Transfer Foundation. IPTV plans to deliver the program over a statewide fiber optic network, the Iowa Communications Network (ICN), which links educational and other public institutions to all 99 Iowa counties (Davis, 1990). Two advantages of the i-TV platform for instruction are: (1) a classroom computer is not required and (2) the video quality of i-TV is superior to that of microcomputers.

The dissertation research was conducted as part of a program evaluation on *Loess Hills Interactive*. The program developers were interested in determining students' and teachers' attitudes and opinions about the program for future projects. Overall, students and teachers reported positive attitudes toward the program, especially the interactive multimedia features which facilitated learner control. The *Loess Hills Interactive Evaluation Report*

(Schlosser & Adamson, 1996) provides a detailed analysis. Technical problems delayed field testing of the program and resulted in interruptions in scheduled use of the program by students participating in the evaluation and research.

Loess Hills Interactive is a resource for middle school science curricula. It presents geological, archaeological, and environmental information about the Loess Hills region in western Iowa. Using this program, students may choose to learn about the Loess Hills from a number of perspectives. Options include viewing extensive video footage of the geology and animals of the area, interviews of experts, historical artifacts, maps, and student field trips. *Loess Hills Interactive* requires learner participation in selecting user options.

Learner choice is a key characteristic of an information-rich learning environment (IRLE), a term used by Yacci (1994) to describe a setting which offers various informational resources. The term may describe, on a micro-scale, a computer-based multimedia program or, on a macro-scale, a physical environment comprising elements which provide learning opportunities, such as a library. *Loess Hills Interactive* exemplifies an IRLE in that students decide which interactive options or informational media segments to access. As students use the program they control decisions about which information to view and their pace through the material. They can access references, including maps and a dictionary, as needed. As they view video segments, they can choose to fast forward, rewind, or stop and move on.

Loess Hills Interactive was designed for use by cooperative groups of students. The user workbook offers suggestions on how to work effectively as a team. As part of the learning experience each group may develop its own multimedia presentation using media elements from the program. Groups earn the capability to choose and save media by answering on-screen questions embedded in program segments. Later, each group may access images during its class presentation about the Loess Hills. The use of cooperative groups as an integral part of the learning experience is a key feature of *Loess Hills Interactive.*

The way teachers structure cooperative learning groups influences student learning experiences. Student gender and group gender composition are two factors which affect interaction patterns and attitudes toward the cooperative learning experience. Interaction patterns among students are different for males and females in groups of varying gender composition (Lee, 1993; Webb, 1984). Females tend to receive more inadequate responses to requests for help than males in mixed gender groups. Females, especially those with low ability, tend to have more positive attitudes toward cooperative learning than males (Dalton, Hannafin & Hooper, 1989). Gender and gender group composition should be examined to give educators and developers input about the design and implementation of educational multimedia.

Statement of the Problem

Educators and developers of multimedia should consider potential differences between males and females as they work with interactive programs. As interactive technology and supporting software create new learning opportunities for students, educators must determine how to most effectively integrate these experiences into the curriculum and implement them in the classroom. Implementation of a learning activity is as a critical factor in achieving educational objectives as the design of the learning activity itself. Most research on gender and gender grouping within cooperative learning contexts has been done with mathematics or problem-solving computer-based software. Little research has been done in IRLE contexts regarding gender and gender composition of groups in cooperative learning situations. *Loess Hills Interactive* presents not only an opportunity to work with a new delivery platform but also a program specifically designed for group work.

Statement of the Purpose

This study presented an opportunity to investigate peer interaction among students working with an interactive multimedia program delivered by an innovative platform, i-TV. Differences in peer interactions and attitudes between males and females in groups of varying gender composition were investigated. Relationships between specific interactions and attitudes for males and females were examined. As interactive technology becomes more sophisticated, the opportunities to enrich and extend learning experiences in the classroom will increase. This study provides information for educators and program designers who are developing and implementing similar technology. The following section identifies the research questions.

Research Questions

Given that gender and group gender composition have an effect on student interactions and attitudes in other learning contexts, the following questions were asked by the researcher:

(1) Do any significant differences in verbal interaction patterns occur between males and females in cooperative learning groups as they

work with interactive multimedia when the gender composition of the groups is varied?

(2) Do any significant differences in attitudes toward their cooperative learning experience occur between males and females using interactive multimedia when the gender composition of the groups is varied?

(3) Are there any significant correlations between verbal interactions and attitudes toward their learning experience of males and females working cooperatively with interactive multimedia?

Definition of Terms

Attitude: "Internal states that express, overtly or covertly, positive or negative evaluative responses to an object, person, or condition," (Snow, Corno, & Jackson, 1996, p. 289). In this study it was used as an indicator of a student's positive response toward the cooperative learning experience.

Constructivist: A model of learning which emphasizes the active building of understanding by students.

Cooperative learning group: A team of three, four, or five students working together with a common goal on a project or assignment.

Digital audio visual interactive decoder (DAVID): A device which allows the user to send and receive information via a remote control to and from a computer at another location.

Information-Rich Learning Environment (IRLE): "An information-rich learning environment (IRLE) is a construct that describes any number of loosely constructed systems in which learners select information resources from which to learn." (Yacci, 1994, p. 328)

Interactive multimedia: "Interactive multimedia refers to any computer-based configuration in which some combination of video, computer-generated graphics, sound, animation, and voice is used.... These multimedia elements can either come from external sources such as videodisc players, VCRs or audio equipment, or they can be generated internally such as when video sound or graphics are stored digitally on a hard disk or optical disk. What gives interactive multimedia its interactivity is the computer. Without the computer, the result is simply multimedia." (Borsook & Higginbotham-Wheat, 1992, pg. 4).

Peer verbal interaction patterns: Statements, questions, and comments which occur among students as they work in small cooperative learning groups.

Traditional lessons: Learning activities which are implemented without the use of educational technology.

Limitations of the Study

Because this research was a field study and part of a more formal evaluation, a number of limitations are of concern:

(a) The subjects were part of a sample already identified by IPTV for participation in their evaluation before the research was designed.

(b) Differences in students, teacher involvement, and program implementation between the two schools were not under the control of the researcher.

(c) The observations over three sessions represented only a sampling of group interactions. Because the two schools used the program during the same time period, it was necessary to devise a schedule between the two schools.

(d) *Loess Hills Interactive* is an IRLE-type of interactive multimedia which was designed for cooperative groups. The learning tasks included searching for information, answering factual recall questions, and developing a multimedia presentation. Students may interact differently with other tasks using alternate educational technology.

(e) The subjects had not previously used i-TV. The innovative nature of the technology may have influenced peer interactions and attitudes.

(f) The subject matter of *Loess Hills Interactive* may have had regional interest to Iowa students. Using this program with students from other geographical areas may result in different findings.

(g) The delivery technology proved to be unreliable during the study and may have influenced student interactions or attitudes. Because of the delays, only students at School A were able to complete a multimedia presentation.

(h) The raters who coded the interaction frequencies from observation tapes may have needed more training time and resources than those available to the researcher.

(i) The frequency distribution of the peer verbal interaction and attitude data was not always normal. The results of the analyses of variance performed on the data may have been affected.

(j) The attitude survey was a self-report instrument and the researcher assumed that students would answer honestly and accurately.

Summary

This quantitative study investigated the cooperative use of the multimedia program, *Loess Hills Interactive,* by middle school science students. The effects of gender and group gender composition on peer interaction patterns and attitudes of males and females were examined. Research using IRLE-type multimedia programs designed for cooperative learning groups is lacking. The results of this study may be helpful to multimedia developers and educators who are responsible for designing and implementing future programs in the curriculum.

CHAPTER II. REVIEW OF LITERATURE

This chapter presents a comprehensive foundation of theory and empirical research related to the present study. The chapter begins with an overview of the implementation of educational technology and cooperative learning in the classroom. A discussion of the classroom use of technology by cooperative groups of students follows. The chapter concludes with a discussion of the effect of gender and group gender composition on peer interaction and attitude.

Interactive Educational Technology in the Classroom

For the purposes of this paper, interactive educational technology refers to the use of computer-based technology to mediate student learning. Multimedia, hypermedia, and CBI are examples of such technology available for the classroom. Using interactive technology, student activities may range from accessing an information database to answering questions as part of a structured lesson. Interactivity infers a degree of control of the pace and/or direction of learning on the part of the learner. Feedback may also be a component of interactivity.

Computers first began to appear in public schools in the late 1970's. The government report *Power On! New Tools for Teaching and Learning* documented the steep rise of percentage of schools with at least one computer by grade level from 10% in 1981 to almost 100% by 1987. Teachers used computers to keep student records and provide curricular support through drill and practice programs, simulations, and applications such as word processing and data bases (Kemp, 1991).

Now, nearly twenty years later, computer programs for every subject area are available. Technological developments such as i-TV allow students to interact with a computer program or each other at a distance. In addition, multimedia capability links several media formats for more versatility by the developers of educational materials and activities. Technology is a powerful tool both for investigating and learning as well as presenting information and ideas (Dede, 1989, 1990).

Models of technology-based learning

Profound changes in our society resulting from the availability of computer-based technologies are challenging the traditional educational paradigm. Most educational systems reflect a teacher-centered model of learning. Traditionally the teachers' role in schools has been to develop lesson plans around predetermined learning objectives, present new information, give students the opportunity to practice, and then try to assess how well the students learned the subject matter. Technology-based learning models reflect the potential of technology to facilitate access to information and ideas outside the traditional learning model (Branson, 1990; Duffy & Jonassen, 1992). Interactive technologies allow students to work at their own pace and give them powerful tools for exploration, research, and presentation of information and ideas. Students especially benefit from using technology as they attempt higher-level learning tasks involving application, evaluation, and synthesis (Perkins, 1992).

Research on educational technology in the classroom

An early research issue for educational technology was the effectiveness of instruction of traditionally presented lessons by a teacher compared with computer-based instruction (CBI). A meta-analysis of 28 qualitative research findings involving use of CBI in elementary schools reported that students who used such technology scored significantly higher on achievement measures than those learning in a traditional manner (Kulik, Kulik, and Bangert-Drowns, 1985). An effect size (ES) was calculated for each outcome in the 28 studies. The results indicated that CBI was more effective in elementary classrooms than in secondary schools or colleges. A subsequent meta-analysis reviewed 82 studies of CBI published between 1980 and 1987 (Roblyer, 1988). An ES was determined for each variable and combined in separate meta-analyses for 17 areas of interest. In contrast to earlier findings, higher effect sizes were obtained at the college levels than at elementary and secondary. The effects were statistically consistent for both genders and all ability levels.

Comparative approaches to research were challenged by Clark (1985). He argued that the significant factor in learning was the message, not the medium: the instructional effectiveness of a lesson reflects the quality of the instructional design. In a subsequent article, Clark (1989) urged researchers to move beyond descriptive methods to prescriptive research methodologies. To accomplish this, a problem must be identified and a thorough search of related literature made before a potential solution to be investigated can be proposed.

Current research focuses on factors which affect technology-based learning: instructional design, program elements, learner control, feedback, and student characteristics (learning style, gender, and ability). Issues surrounding the capability of technology to provide interactive learning among students scattered geographically also are relevant. The next section discusses the use of cooperative groups in the classroom.

Cooperative Learning in the Classroom

The term cooperative learning applies to a spectrum of group learning environments. Cooperative learning occurs when a group of two to five students help each other complete a learning task for which they are rewarded. Guidelines for structuring cooperative learning in small groups have been developed. Two conditions are essential for genuine cooperative learning: (1) group goals and (2) individual accountability (Slavin, 1991). According to Johnson and Johnson (1989), who have examined cooperative learning over a number of years, five elements are fundamental to a cooperative learning environment: (1) positive interdependence, (2) face-to-face promotive interaction, (3) individual accountability, (4) social skills, and (5) group processing. Group dynamics in a cooperatively structured group reflect a blend of individual accountability and group interdependence.

Assigning students to cooperative groups does not guarantee positive outcomes (Hooper, 1992a; Salomon & Globerson, 1989). From empirical studies, Salomon and Globerson (1989) identified four effects which potentially keep groups from working well: 'free-rider,' 'sucker,' 'status differential,' and 'ganging up on the task.' The 'free-rider' effect tends to appear in larger groups when one or more members contribute less than their share to the task at hand. The 'sucker' effect occurs when the more able member perceives he or she is being taken advantage of and decreases his or her contribution to accomplishing the task. When high-status students dominate the group interactions and low-status students in turn retreat from participation the 'status differential' effect occurs. The 'ganging up on the task' effect happens when students of different levels of interest in the task expend energy avoiding the learning task. These deterrents to learning appear within the cooperative team if one or more students either do most of the work or as little as possible. Groups engaging in exploratory activities may be more susceptible to these effects than those involved in activities with prescribed parameters. A potential way to circumvent the occurrence of these debilitating effects is to structuring the group so that all students have responsibility for some part of the task (Salomon & Globerson, 1989).

Model of cooperative learning

Empirical findings were utilized by Webb and Palincsar (1996) in the development of an input-process-outcome model of group processes in the classroom. The model contains four elements: (a) input characteristics, (b) group processes, (c) internal mediating processes, and (d) outcomes. Input characteristics include group composition (ability, ethnicity, gender), group size, and structuring of group interaction and the teacher's role. Group processes identify: (a) conflict and controversy, (b) co-construction of ideas, (c) giving and receiving help, and (d) socio-emotional processes. Internal mediating processes are unobservable events hypothesized to explain how the group processes influence outcomes. Both cognitive and noncognitive outcomes (social, motivational, and attitudinal) are part of the model.

The model identifies the range of research issues associated with cooperative learning. The following section moves from the theoretical to the practical by describing methods of structuring cooperative learning groups for students.

Cooperative group methods

A number of cooperative group methods, based on factors such as how tasks are completed and rewards are given, are currently used in the classroom. Various models have been developed by Slavin (1995): Student Team Learning (STL), Student Teams-Achievement Divisions (STAD), Teams-Games-Tournament (TGT), Team Accelerated Instruction (TAI), and Cooperative Integrated Reading and Comprehension (CIRC). Other models include: Jigsaw and Jigsaw II (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), Learning Together (Johnson & Johnson, 1994), and Group Investigation (Sharan and Sharan, 1992). Models offer theoretical and practical guidelines to teachers for selecting an appropriate cooperative learning structure based on curricular criteria such as learning objectives and rewards (Slavin, 1995). Teachers may use any number of variations when implementing groups in the classroom.

Research on cooperative learning

Research on cooperative learning in the 1960's through the 1980's primarily compared cooperative, competitive, and individualistic learning environments (Thompson, Simonson, & Hargrave, 1992). Findings encouraged teachers to use cooperative learning with their students. Meta-analysis of research on cooperative learning examined 122 comparative studies involving a comparison between at least two environments:

cooperative, cooperative with intergroup competition, competitive, and individualistic. Results suggested that cooperative learning more effectively facilitated student achievement and productivity than other environments (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981).

Cooperative learning promotes positive outcomes in many areas important to educators: achievement, motivation, and peer perception (Johnson & Johnson, 1985; 1989; Kagan, 1985; Maskit & Hertz-Lazarowitz, 1986; Petersen, Johnson, & Johnson, 1991; Simsek & Hooper, 1992; Skon, Johnson & Johnson, 1989; Slavin, 1990, 1995; Webb, 1996; Yager, Johnson, & Johnson, 1985). The positive effects of cooperative learning seem robust across ages, ability levels, and subjects (Bossert, 1989; Slavin, 1995). Grouping students cooperatively is widely encouraged by curriculum guides and standards across subject areas (National Council of Teachers of Mathematics, 1989; National Research Council, 1989; Pozzi, Healy, & Hoyles, 1993). The next section examines the use of technology combined with cooperative learning.

Technology-based Cooperative Learning in the Classroom

Students benefit from using interactive educational technologies cooperatively in the classroom (Adams, Carlson, and Hamm, 1990; Adams & Hamm, 1996; Goodrum, Dorsey, and Schwen, 1993; Johnson, Johnson, & Stanne, 1986). Both technology and cooperative learning facilitate active student engagement: cooperative learning by encouraging students to interact with each other to accomplish the learning task (Slavin, 1995) and technology by demanding attention to the task (Jernstedt, 1983). Another common characteristic of cooperative group structures with technology is the opportunity for the teacher to become a facilitator, rather than director, of the learning process.

Models of technology-based cooperative learning

Models of technology-based cooperative learning emphasize both the potential of the technology and the importance of peer interaction for the learning process. Computer enhanced collaborative learning (CECL) is used to describe an environment that couples the positive impact of peer interaction on student cognitive and affective domains with the instructional effectiveness of technology (Jernstedt, 1983). Three ways students benefit from involvement with CECL are: (a) computer programs direct learning activities, (b) increased time on task, and (c) peer verbal interaction.

Technology-mediated interactive learning (TMIL) is another model of technology-based cooperative learning (Dede, 1990). The model expands the concept of face-to-face peer interaction to communication among students at a distance. Three parameters describe TMIL: (a) the technology either mediates interaction among participants or provides a common environment, (b) the technology provides tools or experiences that enrich learning individually and collectively, and (c) the interaction by those persons who participate is spontaneous. According to Dede (1990), the following factors impact the evolution of distance education: technological advances and demographic, economic political, and pedagogical forces.

CECL and TMIL are two examples of how students use educational technology cooperatively. They reflect the current direction of technology-based learning in the classroom, a direction based on these two effective ways of presenting and structuring learning in the classroom. The next section will briefly review research efforts in this area.

Research on technology-based cooperative learning

Early research paralleled the direction of cooperative learning research. Comparisons were made of the effectiveness of cooperative, competitive, or individualistic computer-based learning. Cognitive and affective student outcomes in cooperative computer-based environments paralleled positive findings for such learning in traditional environments (Dalton et al., 1989; Johnson, Johnson, & Stanne, 1986). Current research in this area includes investigations of group composition by ability and gender, peer interaction, learner control, and lesson design. The next section discusses peer interaction, gender, and group gender composition.

Peer Interaction: Gender and Group Gender Composition

This section discusses gender and group gender composition, two factors which have an effect on interaction patterns. The relationship of peer interaction to learning is examined. Empirical studies which investigated either the gender of the student or the gender composition of the cooperative group, or both, are reviewed. Studies are identified as involving either traditionally delivered or technology based lessons.

Peer verbal interaction and learning

Peer verbal interaction is a fundamental aspect of cooperative learning (Bouton & Garth, 1983; Johnson & Johnson, 1986; Webb, 1985). Through interaction students communicate with each other to accomplish the learning task. Students who interact verbally with each other benefit cognitively from other students' knowledge and perspectives (McCombs, 1985; Pozzi et al., 1993). Students who explain information to others reinforce their own ideas and those who hear different points of view examine their own ideas (Riel, 1989; Webb, Troper, & Fall, 1995). Giving explanations to others encourages learners to clarify or reorganize material in new ways, recognize and fill in gaps in understanding, recognize and resolve inconsistencies, develop new perspectives, and construct more elaborate conceptualizations than if they learned material by themselves (Jernstedt, 1983; Slavin, 1985).

The amount of peer interaction among students is affected by grouping and program design factors (Bailey, 1992/1993; Simsek, 1993). Higher interactions occur with high-ability students when compared with those of lower ability. Students grouped heterogeneously by ability tend to interact more frequently than those homogeneously grouped. Students using a program with learner control interact more highly than those without learner control.

Peer interaction and task. The types of peer interactions occurring among students are related to the learning task. A difference exists between interactions which facilitate learning for tasks with clearly-defined answers those with ill-defined solutions (Cohen, 1994). She reported a positive relationship between the frequency of interactions and measures of achievement for cooperative students attempting an ill-defined problem. This finding is not consistent with results from research with students attempting well-defined solutions, which did not find a correlation between achievement and the total number of student interactions (Lee, 1993; Webb, 1984).

Interactions specific to students using an IRLE-type program have not been clearly identified. However, learning strategies used by students in such an environment have been identified. Examination of task accomplishment by students using an IRLE-type program reflected a variety of possible strategies (Yacci, 1994). A factor analysis of learner choices revealed eight factors which influenced learner choice: (1) see it done well, (2) active/passive learning, (3) enjoying adventure, (4) complete the assignment, (5) processing time, (6) self-testing, (7) easy, and (8) big picture/detail. In a learning group several strategy preferences might be represented.

Peer interaction and achievement. Particular interactions among students tend to promote or discourage achievement. Giving and receiving help when needed are positively related to achievement. However, not receiving needed help is negatively related to achievement (Hooper, 1992a; Webb, 1984).

Hooper (1992b) and Simsek (1992, 1993) obtained similar findings for technology-based learning. Interaction patterns among fifth- and sixth-graders using CBI were investigated by Hooper. Generating and receiving help were two significant factors relating to achievement. Simsek found positive correlations between providing elaborations, seeking clarifications, and achievement scores in two studies, with students using CBI (1993) and with those using interactive video (1992). A negative relationship between off-task interactions and achievement was also reported for students using CBI.

Webb et al. (1995) further examined the relationship between receiving needed help and achievement. A positive relationship between receiving needed explanations, as differentiated from only the right answer, and using the help in constructive problem-solving activity was hypothesized. Interactions among 166 students assigned to small collaborative groups were tape recorded for later analysis. Of these, 119 were identified as needing help with the math problems if they made an error, asked for help, or indirectly indicated a need for help. The level of help that a student received was coded on a continuum from highest elaboration to lowest elaboration. The results indicated a strong positive relationship between achievement as measured by a posttest and level of constructive activity engaged in by students after receiving needed help. When the data was analyzed by group and prior achievement was taken into consideration, a similar positive relationship was evident between high levels of constructive activity and achievement. The most effective level of constructive activity was reworking the problem from the beginning.

The next two sections examine the effect of gender and gender group composition on peer interaction. Studies in which students worked with traditional lessons are presented first, followed by research conducted with interactive technology. Each section is subdivided by the type of task students were required to complete during the study.

Peer interaction, gender, and group composition in traditional lessons

Webb (1984, 1985) observed differences in interactions between male and female math students related to their group membership. Three types of gender groupings were used: majority female, majority male, and equal males and females. In groups with equal numbers of males and females, students showed equal achievement and similar interaction patterns. In groups with a female majority, females directed most of their interactions to males and showed lower achievement than males. In groups with a male majority, males tended to ignore females and showed somewhat higher achievement than females. The positive relationship between giving and receiving explanations confirmed earlier findings (Webb, 1984).

The later study examined gender composition on achievement and interaction patterns using three types of groups and six interaction variables: giving, asking for, and receiving explanations; giving asking for, and receiving procedural information. The results indicated similar achievement and interaction patterns only for groups with equal males and females. In groups with a majority of either males or females, males had higher achievement and received attention more frequently than predicted. Females gave more explanations and information to males than females. In groups with a majority of males, males interacted with each other and tended to ignore females (Webb, 1985).

Peer interaction, gender, and group gender composition in technology-based lessons

Interactions among students working with technology-based lessons may differ from those among students completing traditional learning activities. Interactive technology influences the kinds of peer interactions students experience among themselves as they are decide where to go and answer questions (Seels, 1989). The following studies examined gender or group gender composition or both of students working with interactive technology. The studies are grouped according to the learning task which students were asked to complete during the study.

Simulations. Differences between males and females were examined as students used a computer-based geography simulation. Students were assigned to cooperative, competitive, and individualistic methods. In their interaction patterns, males tended to be more competitive and off-task, while females were more cooperative (Johnson et al., 1986).

Logo. Status effects, or perceptions of gender, were determined to be a factor in how groups interacted. Forty-eight students, age nine to twelve, were assigned to groups of six with equal gender composition. Students completed three research tasks, two with Logo and one with a database. Data was collected by taking videotapes and field notes (Pozzi et al., 1993).

Guntermann and Tovar (1987) found differences between male and female interactions with a Logo problem-solving task. Thirty-six students, age ten, were assigned to dyads and triads with same-gender or mixed-gender composition. The short-term study involved students in one learning session, one practice session, and one experimental session. The Bales Interaction Process Analysis, with three main categories, positive socio-emotional, task area, and negative socio-emotional, was used to code interactions. Significant differences occurred between males and females in various group compositions. Males showed more group cohesiveness. Females tended to agree with group members more than males. Males in same-gender groups tended to ask more questions than males in mixed-gender groups and were more antagonistic than females or males in mixed-gender groups. One limitation of the study was the short duration of the project.

Language tasks. Underwood, McCaffrey, and Underwood (1990) investigated task completion by dyads of students in three gender groupings: same-gender and mixed-gender. Students worked on a computer-based language activity. They found that same-gender dyads were more effective in completing the language task than mixed-gender groups.

Signer (1992) examined student behaviors using a model of computer-based cooperative learning in which all teams could attain their goals: Cooperative Learning Intergroup Competition (CLIC) Model. Students were required to generate inferred answers from a story. Eighteen female pairs, 13 male pairs, and eight mixed-gender pairs participated over a full semester. Data collection was conducted by observations, videotapes of sample groups, interviews, and open-ended and agree or disagree questionnaires. Unlike the male same-gender or mixed-gender teams, female teams tended to: (a) be demonstrative after each correct answer, (b) be apprehensive about correctness of answers, (c) alternate reading paragraphs aloud, and (d) discuss responses before entering them into the computer (p. 151). These findings supported results from other studies in which female dyads verbalized more and in lengthier segments and exhibited less confidence toward their answers than males.

Interactive structured lesson. Gender pairings of students using an IV science lesson were examined by Dalton (1990). Differences in attitude, instructional time, and efficiency between males and females were found. Dependent variables were interaction, achievement (multiple choice posttest of basic facts), and attitudes (two Likert-type surveys examining attitudes toward cooperative learning, the lesson delivery system, and attitudes to lesson content and science in general). Transcriptions of audiotapes were classified by: (a) management, (b) social, (c) task, and (d) content interaction. Ninety-eight fifth-and sixth-grade students were randomly assigned to same-gender and mixed-gender pairs. Students discussed possible answers to questions before entering their group response. A multivariate analysis of variance (MANOVA) revealed a relationship between gender and treatment. Same-gender pairs scored higher on the posttest than mixed-gender. Same-gender pairs also took longer to finish the task. Males exhibited more competitive behavior than females, especially over keyboard control. The competitive behavior was perceived by the researcher as obstructing learning. Females had more task-oriented behavior. The type of task may have influenced results, because the recall of verbal information does not particularly require collaboration. Another limitation to the study was its short treatment.

Problem-solving. Lee (1993) used a Peer Interaction Coding System developed during a pilot study to identify significant interaction differences between males and females depending on group membership. The four main interaction categories were: (a) task-related, (b) procedure-related, (c) socio-emotional, and (d) miscellaneous off-task. Four variations of gender composition were examined: (a) same-gender, (b) majority-males, (c) majority-females, and (d) equal-gender. Observation data was taken from videotapes of students working with the problem-solving program *Carmen San Diego.*

Overall, the percentages of interactions were as follows: task-related, 80%; procedure-related, 8%; socio-emotional, 11%; and off-task, less than 1%. Differences in interaction patterns between males and females, based on group membership were found. Males had more verbal interactions in groups with both males and females than only males while females became less verbal in mixed groups. For the same-gender groups, females were more likely to interact with each other and to give task-related help and receive procedure-related help than males. In majority-male groups, the males gave more task-related help and were more likely to ask a question and receive procedure-related help than females. In majority-female groups females were more likely to give task-related help and males were more likely to ask a question and receive procedure-related help. In equal-gender groups males were more likely to interact with group members and give task-related help than females. In equal-gender, majority-male, and majority-female groups females were more likely to ask a question and receive inadequate task-related help than males. One limitation of the research is that the sample contained only 64 students, resulting in minimal cell sizes for statistical analysis. Also, findings may not generalize to other types of computer-based activity.

Summary

Gender and group gender composition are significant variables affecting interaction among students during cooperative learning with various types of computer-based learning activities: Logo, simulations, language tasks, and problem-solving. Findings reflect potential differences between males and females in interactions and differences among groups of varying gender composition in interaction patterns. Results are mixed for understanding the relationship between group gender composition and achievement.

Attitude toward Cooperative Learning

Attitude and learning

Students in cooperative groups indicate a more positive attitude toward peers and cooperative learning in general, compared with students in competitive or individualistically structured learning environments (Johnson et al., 1986; Simsek & Hooper, 1992). Working together fosters in students a perception of peer friendliness, helpfulness, and status (Hill & Hill, 1990; Johnson & Johnson, 1985; Sharan, 1980). The positive effect of cooperative learning on student affective outcomes occurs with both traditional and technology-based learning.

A long-term study which examined group interactions among students in 18 fourth- through sixth-grade classrooms found that the quality of group interactions were a major determinant of both affective and cognitive student outcomes (Battistich et al., 1993). High-quality interactions were defined by friendliness, concern, and helpfulness and were associated with positive attitudes toward school, self, and achievement. Low-quality interactions, characterized by the absence of high-quality factors, were associated with negative student outcomes.

A positive relationship between student attitude toward cooperative learning and perceptions of being cared about and helped by teachers and peers was found by Johnson, Johnson, and Anderson (1983). Students in fifth through ninth grades were surveyed on twelve constructs including attitude toward cooperative learning, student academic support, and resource interdependence. The findings reflected a direct relationship between cooperative attitudes and factors of a positive classroom environment, including perceptions of peer helpfulness.

A positive attitude toward cooperative learning may also be influenced by design and implementation factors in the technology learning environment, such as learner control (Simsek, 1992; 1993). When attitudes toward cooperative learning were compared for groups of students using CBI, students in the learner control groups had significantly higher attitudes than those in program control groups (Simsek, 1993). A significantly higher attitude was also found for students in heterogeneous ability groups as compared with homogeneously-grouped students. Low ability students in heterogeneous groups had a significantly higher attitude toward cooperative learning than those in homogeneous groups. These results supported earlier research (Simsek, 1992) which examined attitude toward group work. Students were trained in cooperative strategies in two sessions. An overall higher attitude (toward group work, content, and delivery system) was found for heterogeneous groups, especially those with low-ability students.

The following discussion of attitude toward cooperative learning includes both traditional learning studies and those using technology-based environments. No studies were located that examined group gender composition and attitude toward cooperative learning. The studies are organized by similarity of research findings.

Attitude and gender

Females may prefer cooperative over competitive and individualistic learning. Differences between males and females were found for preferences between individual and cooperative learning. Dalton, Hannafin, and Hooper

(1989) examined the effect of ability on preference for cooperative learning between males and females working with CBI. Low-ability males preferred individualized instruction and low-ability females cooperative methods. No significant differences in attitude were found between high-ability males and females.

A two-way interaction between grade and gender for attitude toward cooperative learning was reported by Engelhard and Monsaas (1989). One hundred seventy-nine third, fifth, and seventh-grade students completed a cooperative attitude in school settings (CASS) scale developed by one of the researchers. Females preferred cooperative learning more than males in third grade but the difference was not apparent in fifth- and seventh-graders.

The number of studies examining attitude in relationship to group gender composition is limited. A number of studies investigated attitude toward content or learner control versus lesson control or instructional delivery system. None of the located studies specifically targeted attitude toward cooperative learning with relationship to group gender composition.

Summary

The effect of gender on attitude toward cooperative learning has a limited empirical research base from which to generalize. Females tend to prefer cooperative learning more than males, although this effect may be limited to younger ages. Research on group gender composition has focused on other affective outcomes other than attitude toward cooperative learning.

Summary

Cooperative learning and interactive multimedia technologies both encourage active student involvement with the learning task. How the cooperative groups are structured can influence the effectiveness of the learning activity. Gender and group gender composition are two factors which can affect verbal interaction patterns and attitude toward cooperative learning. However, questions remain regarding how group membership can influence peer verbal interaction and subsequent cognitive and affective outcomes for males and females.

CHAPTER III. METHODOLOGY

This chapter discusses the methodology of the research project. The subjects, equipment, instruments, and procedure are described. The research study was conducted in collaboration with a formal evaluation of *Loess Hills Interactive* completed by the researcher and her colleague, with the permission of IPTV (Schlosser & Adamson, 1996).

Subjects and Schools

Subjects

A total of 127 seventh- and eighth-grade students participated in the study, of which 60 (47.2%) were male and 67 (52.8%) female. Students were Students were randomly assigned to four-person groups with the following gender compositions: (a) same-gender, (b) mostly-males, (c) mostly-females, and (d) equal-gender. Twelve groups of three students each and three groups of five were included because class sizes were not always divisible by four. The groups of three and five students were assigned to the same gender composition categories as groups of four. A total of 34 groups, 17 at each school, were included in the study. The total number of groups for each group composition categories were as follows: same-gender, 6; mostly-male, 12; mostly-female, 11; and equal-gender, 5. See Table 1 for the numbers of students, by gender, and groups per school.

Schools

The research was conducted at two Iowa middle schools. Student populations of both schools were predominantly white. IPTV provided on-line access at each school to *Loess Hills Interactive* for approximately four weeks. Technical problems with the delivery of the program resulted in schedule modifications at both schools.

School A. School A was a middle school for fifth-, sixth-, seventh-, and eighth-graders in a middle-class suburb of a large metropolitan area. The students were all seventh-grade science students from four classes of one teacher. In order to access the i-TV hardware, students and their teacher walked across a parking lot to the high school media center for each class session. Students using *Loess Hills Interactive* were supervised by their teacher through a window from an adjoining classroom. Two classes (10 groups total) were on a five-day rotation and two classes (7 groups total) were on a six-day rotation. Each group was scheduled for 65 minutes. The teacher maintained a high level of involvement with the students in two ways: (1) visual contact with the groups as they worked with the program and (2) discussion in the classroom of the scientific concepts presented in *Loess Hills Interactive*. Students were graded on their written work and final group presentations.

School B. School B was a middle school located in the same building with the high school. Students came from a number of rural communities in southwest Iowa. Both seventh- and eighth-grade students from classes of two teachers were selected. Five of the six classes were general science classes. One class was composed of thirteen talented and gifted (TAG) students (4 males and 9 females). Access to the program was in a separate room within the building. All

Table 1. Subjects and groups by school.

Groups	Same Gender	Mostly Male	Mostly Female	Equal Gender	Total
School A					
3-Student Groups	**1**	**5**	**1**	**0**	**7**
Males	3	10	1	0	14
Females	0	5	2	0	7
4-Student Groups	**2**	**2**	**3**	**2**	**9**
Males	4	6	3	4	17
Females	4	2	9	4	19
5-Student Groups	**1**	**0**	**0**	**0**	**1**
Males	0	0	0	0	0
Females	5	0	0	0	5
Total Groups	**4**	**7**	**4**	**2**	**17**
Males	7	16	4	4	31
Females	9	7	11	4	31
School B					
3-Student Groups	**2**	**2**	**1**	**0**	**5**
Males	3	4	1	0	8
Females	3	2	2	0	7
4-Student Groups	**0**	**3**	**4**	**3**	**10**
Males	0	9	4	6	19
Females	0	3	12	6	21
5-Student Groups	**0**	**0**	**2**	**0**	**2**
Males	0	0	2	0	2
Females	0	0	8	0	8
Total Groups	**2**	**7**	**4**	**2**	**17**
Males	3	13	7	6	29
Females	3	5	22	6	36
Total Groups	**6**	**12**	**11**	**5**	**34**
Male	10	29	11	10	60
Female	12	12	33	10	67
Total	**22**	**41**	**44**	**20**	**127**

the groups were on a five-day rotation and were scheduled to work with the program 45 minutes per week. The groups were supervised by available school and research personnel. The two participating teachers could not integrate the program into the semester's scheduled science curriculum. Therefore, the scientific concepts presented in the program were not reinforced by other classwork and students were not graded on their work. Groups were prevented from completing multimedia presentations because of the technical problems with the program delivery.

Technology

The technology used to conduct the study consisted of: (a) the i-TV program, *Loess Hills Interactive,* and the hardware required to deliver it to students; and (b) video recording equipment for documenting observations. As they worked in their groups, students completed answers to questions from the user workbook. The program and delivery system, the video equipment, and the workbooks are described in more detail below.

The interactive multimedia program and the delivery technology

During the study, students used the interactive program, *Loess Hills Interactive,* described earlier. The program is an interactive multimedia collection of video segments, still photographs, and references (maps, dictionary, and bibliography) about the Loess Hills region along Iowa's western border. The program allowed groups to save portions of the multimedia to a group file after students earned enough points. Groups earned points in two ways: (1) by answering on-screen questions embedded in the main collection of videos, and

(2) by answering on-screen quiz questions. The multiple-choice questions required students to choose from among either two or three suggested answers. Students received feedback on their response immediately afterward. If they did not answer correctly, they were told the correct answer.

The program was stored on a server at ICN headquarters. A T-1 high-density phone line connected students to the ICN. A DAVID box, which allowed students to interact with the program over the ICN using a remote control, connected the T-1 line to a television monitor in the classroom. Technology using a DAVID box is referred to as interactive television (i-TV) by the developers.

Video recording hardware

The video equipment and arrangement developed during an earlier pilot study were used to record the peer interactions among groups of students as they worked with the program (Adamson, 1996). A professional-quality video camera on a tripod beside the television monitor recorded students' faces. A backup camera, behind the students, faced the television screen. Both cameras were fitted with an external conference-type microphone, placed on the table in front of the students. Students sat next to each other on two adjacent sides of the table angled in front of the television monitor. This arrangement facilitated viewing all the students' faces within the angle of the camera lens.

Student worksheets

While using the program students each completed three worksheets included in the user workbooks. Worksheet questions covered information from the main video geology, fauna, and preservation/environment. Each student recorded his or her own answers on the worksheets. See Appendix A for the three worksheets.

Instruments

Peer Interaction Scale

Description of the Peer Interaction Scale. The Peer Interaction Scale identified major categories of peer interactions which occurred among students as they worked cooperatively with *Loess Hills Interactive*. Raters tallied the number of times each specific interaction occurred during the observation time segments. The assignment of an interaction to a category depended on the content or intent of the interaction. Interactions were assigned to one of five main categories: (a) path or pace through program, (b) task, (c) socio-emotional, (d) technical, (e) off-task, and (f) uncodable.

Path/pace interactions influenced the direction or speed of accessing information. Students asked for or gave information about navigating the program. Subcategories were: (a) asking for information/help, (b) giving information/help, and (c) testing of hypothesis. Sample verbal interactions included:

Should we look at geology or environment?
Where do you want to go?
I think you're supposed to do the main videos first.
Wait, wait, stay there.

Task interactions related directly to answering questions, either in the workbook or on-screen, and developing the project. The subcategories were: (a) asking for information/help, (b) giving information/help, and (c) testing of hypothesis. Examples of task interactions included:

What is the answer to #4?
What did they say was the environment of the red fox?
We haven't seen this.
I think it's because of the wet environment.

Socio-emotional interactions influenced group dynamics among team members. The subcategories included: (a) encouraging group or individual; (b) discouraging group or individual; (c) responding positively to program/task; (d) responding negatively to program/task; (e) responding generally to program/task; and (f) joking/being silly. Some socio-emotional comments made by students were:

We're on a roll. (encouraging)
We're never going to figure this out. (discouraging)
I like this guy. (positive response to program)
This is stupid! (negative response to program)
Oh! (general response to program, unclear whether an emotional connotation is inferred)
Froggy, froggy! (joking, silly)

Technical interactions focused on students' problems with the technology. Examples of technical interactions were:

What happened to the picture?
When is it going to start again?

Off-task interactions were not related to the program. A few samples included:

I'm going to my grandmother's this weekend.
What time is it?

Uncodable interactions occurred when: (a) students just made noises or (b) students spoke too quietly for the rater to understand.

The rater completed two tally sheets for each student, one for each ten-minute observation segments. The tallies from both segments were combined for an overall total for each main category and subcategory. See Appendix B for the interaction tally sheet.

Development of the Peer Interaction Scale. Several peer interaction coding systems were used as models in the development of the Peer Interaction Scale. Two limitations applied to the systems. It was not possible to ascertain enough detail in the literature about implementation to allow confident use of any one of them. Interactions occurred which were difficult to categorize. Also, the systems were not developed for interactions in groups using IRLE-type interactive multimedia. Interactions related to navigation through the program were not identified.

Data from the pilot study completed in preparation for this study contributed to the development of the Peer Interaction Scale. Observations recorded during the pilot study were used to identify the types of interactions which occurred as students worked cooperatively with the program. First, a match was attempted between prospective categories and transcriptions of several group interactions. Second, two research experts, who frequently use observation techniques, shared input pertaining to this study. Third, several prototypes of interaction scales were refined until all interactions could be categorized. The identification of low-inference categories was a priority in order to facilitate the decision-making process as raters tallied interactions.

High- and low-quality interactions affect student achievement (Battistich et al., 1993). In the Peer Interaction Scale, high-quality interactions were identified as directly contributed to accomplishing the tasks involved in *Loess Hills Interactive*. The learning activities included: (a) completing the worksheets, (b) earning points by answering on-screen questions, and (c) developing a presentation using media elements of the program. Other high-quality interactions included those related to group dynamics: (a) monitoring the group, (b) helping with the remote, (c) giving positive comments to the group or an individual, and (d) participating in positive corporate expression. Low-quality interactions were identified as those distracting from group or individual accomplishment: (a) refusing to operate the remote control, (b) making negative comments about the program, (c) addressing negative comments to the group or an individual, and (d) making off-task remarks.

Training of the raters. To establish a sufficient reliability among the three raters, a training protocol was implemented using the Peer Interaction Scale and pilot study videotapes. Raters (one male and two females) trained for approximately six hours. The training procedure was as follows: (1) initial discussion of the interaction scale, (2) viewing of an observation tape and completion of the tally form with the researcher and rater working collaboratively, (3) discussion of subsequent questions, (4) independent completion of a second tally form by the raters, (5) comparison of results with each other and discussion of questions and discrepancies, (6) coding of a third segment separately by the raters, and (7) resolving of any final questions.

Two ten-minute video segments for each group were selected using detailed logs made during the observations. The logs showed where in the program each group spent time in the program during their sessions. The selected segments represented the observation time potentially highest in verbal interactions among group members. Each of the three raters coded approximately eleven groups or 42 students each. Raters coded interactions one student at a time, watching every ten-minute time segment repeatedly for each student in the group. See Appendix C for guidelines used by raters to code interactions.

Attitudinal survey

Description of the attitudinal survey. Students responded to statements on the attitudinal survey by circling a number on a six-item Likert-like scale: (a) 1, strongly disagree (SD), (b) 2, disagree (D), (c) 3, moderately disagree (MD), (d) 4, moderately agree (MA), (e) 5, agree (A), and (f) 6, strongly agree (SA). The statements were included in the third section of a survey administered with a formal evaluation of the program (Schlosser & Adamson, 1996). Statements were grouped by themes of theoretical interest: (a) attitude toward group learning, (b) emotional reaction to one's group, (c) perception of group accomplishment, (d) perception of group participation, (e) perception of one's own helpfulness, and (f) perception of peer helpfulness. See the attitudinal survey in Appendix D.

Development of the attitude survey. Data collected on 52 students during the pilot study (Adamson, 1997) were used to develop the attitudinal survey. High-quality interactions produce a generally positive attitude and perception of peer friendliness and helpfulness by group members (Battistich et al., 1993). Two preliminary forms of the survey were used during the pilot study sessions. Qualitative feedback on the survey from three teachers, several experts, and students was obtained. The final form of the survey used in the research study consisted of 20 statements.

Factor analysis. After the students completed the attitudinal survey a factor analysis of the data was computed. The factor analysis procedure used a varimax rotation technique on SPSS. Data was used in its orignial form, unreversed. Only factors with Eigenvalues higher than 1.0 were identified. Five factors emerged from this analysis: (1) positive emotional reaction to the group, (2) presence of helping behaviors in the group, (3) preference for working alone,

(4) lack of helping behaviors in the group, and (5) preference for small-group learning. The statements that loaded higher than .6 on each factor were evaluated to determine a common theme. The reliability and statements included for each factor are reported in Table 2. See Table 3 for the factor loadings and Eigenvalues for the factors. The five factors which emerged from the factor analysis were used as the five dependent attitude variables for the statistical analyses.

Procedure

The procedure used to videotape the observations and administer the attitudinal survey, and the problems encountered in implementing the procedure are described in this section. All students received a letter explaining the details of the research study. Parents were asked to return the form if they did not want their son or daughter to participate. See Appendix E for the parental permission letter. See Appendix F for the Review of Research Involving Human Subjects form.

Observations

A three-week observation plan for both schools was devised. Groups at School A were scheduled to be observed the first two days of Week One, the last three days of Week Two, and the first two days of Week Three. The plan was reversed for School B: the last three days of Week One, the first two days of Week Two, and the last three days of Week Three. This arrangement provided a sampling of interaction data from groups from all three sessions to account for any differences in interaction patterns due to the group session number. The

Table 2. Reliability coefficients for attitude survey factors.

Factors	Reliability Coefficient
Factor 1: Positive emotional reaction to the group	**.85**
51. I liked working with my group.	
53. I would choose to work in this group again.	
55. Group members helped each other complete the lesson.	
58. Everybody in my group got to participate.	
65. My group members were helpful to me.	
Factor 2: Presence of helping behaviors in the group.	**.79**
59. The group listened to everyone's ideas.	
61. My suggestions and explanations helped other group members with the lesson.	
62. I helped group members when they had questions about the lesson.	
64. I helped my group make decisions during the lesson.	
Factor 3: Preference for working alone.	**.81**
49. I usually prefer to work by myself.	
52. I would have been more comfortable working alone.	
57. I could have accomplished more working alone.	
Factor 4: Lack of helping behaviors in the group.	**.61**
63. I did not help answer questions in my group.	
66. When I asked a question, my group members did not help me.	
Factor 5: Preference for small group learning.	**.71**
48. Working in small group makes learning fun.	
50. Working in small groups helps me learn better.	

Table 3. Factor loadings and Eigenvalues for attitudinal factors.

Survey	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
53	.744	.042	-.294	-.026	.129
58	.738	.223	.094	-.259	.211
55	.697	.381	-.060	-.055	.014
51	.694	-.063	-.201	-.022	.456
65	.676	.407	-.344	-.163	-.043
56	.508	.180	.127	-.472	.277
60	.486	.426	-.073	-.290	.283
61	.243	.820	-.002	-.080	.061
62	.057	.755	.146	-.060	.115
64	.094	.702	-.045	-.275	.084
59	.459	.610	-.169	-.284	.037
52	-.032	.010	.884	.033	-.218
49	-.066	.112	.787	.013	-.299
57	-.189	-.022	.704	.283	-.093
67	.414	.433	-.458	.015	-.122
63	.045	-.223	.045	.788	-.102
66	-.341	-.131	.313	.663	.037
54	-.355	-.179	.444	.490	.147
48	.133	.154	-.196	-.094	.850
50	.292	.133	-.318	-.000	.753
Eigenvalue	7.297	2.578	1.512	1.207	1.070

number of groups per session were: session #1, 17 groups; session #2, 8 groups; and session #3, 6 groups. Session data was unavailable for 3 groups.

When each new group of students arrived in the observation room they logged on the program and viewed an introduction in which the video host discussed how to navigate the program and use the video controls. If the group was on the second or third session with the program they immediately logged on and began working. Students were instructed to use the program without input from the researcher except when technical problems arose.

A detailed log was made of the path through the program and the length time spent in each program segment. Notations about technical problems and types of interactions occurring among the students also were made. Observations did not include any student presentations.

Attitudinal survey

The attitudinal surveys were administered to subjects in both schools after observations were completed. As stated earlier, the survey was part of a larger attitudinal survey which included other research and evaluation constructs. Students completed the survey during one class period.

Problems encountered in data collection

Observations. A number of problems in making observations occurred:

(a) The proposed schedule was modified by unforeseen circumstances. Technical problems in delivering the program over the fiber optic system occasionally prevented students from working on their assigned day or shortened their session time. As a result the collected data did not represent the proposed plan.

(b) The groups at School B could not complete their final presentations because of technical problems. Their responses on the attitudinal survey did not reflect experiences in developing a presentation.

(c) Adults attempting to correct technical problems possibly influenced the interaction patterns among students.

(d) Unanticipated changes in school scheduling interfered with data collection.

(e) Student absences changed the gender composition of several groups from what was originally assigned.

Attitudinal survey. Several problems occurred during the administration of the surveys which resulted in lost or unreliable data.

(a) Student absences lowered the number of completed surveys.

(b) Students failed to respond to some statements, resulting in lost data.

(c) A small number of students gave a response set on the survey which raised doubts about the honesty of their answers. This may have influenced the reliability of the survey data.

Numerous problems occurred outside the researcher's control. The most critical circumstance was the technical unreliability of the program delivery system. In addition, student absences impacted the amount of data collected.

Data analyses procedures

Data analysis began with a rough comparison of means between groups and gender for all of the dependent variables. Two-way analyses of variance using the two original independent variables, gender and gender group composition, were then computed. Separate two-way analyses of variance were examined for each dependent peer interaction (total, path/pace, task, socio-emotional, technical, off-task, and uncodable) and attitudinal variable (Factor 1, positive emotional reaction to the group; Factor 2, presence of helping behaviors in the group; Factor 3, preference for working alone; Factor 4, lack of helping behaviors in the group; and Factor 5, preference for small-group learning). Because the analyses of variance did not reveal significant gender differences, exploratory one-way analyses were done using school and grade as independent variables. Both grade (7 and 8) and school (A and B) were determined to have significant differences. School was chosen as the more potentially more powerful variable. Three-way analyses using gender, group composition, and school were completed, but the cell sizes became unacceptably small. A complete set of two-way analyses of variance were subsequently run for each dependent interaction and attitudinal variable using group composition and school as the independent variables. The results for both sets of two-way analyses of variance are reported and discussed. Significant effects for group composition were further examined using the Fisher protected least significant difference (PLSD) test. Pearson product-moment analyses were used to determine correlations between peer interaction and attitudinal variables.

Summary

One hundred twenty-seven middle school science students from two schools participated in the study. Students were assigned to groups of three, four, and five: (a) same-gender, (b) mostly-males, (c) mostly -females, and (d) equal-gender. Videotaped observations were made of groups working with the i-TV program, *Loess Hills Interactive*, over a four-week period. An attitudinal survey was completed by students following program sessions. The technology, instruments, and procedure used to collect data were developed from a pilot study completed prior to this research study. Data collection was limited by circumstances at the schools and technical problems with delivery of the program.

CHAPTER IV. RESULTS

The findings of the data analyses are organized and discussed by the three research questions: (1) Do any significant differences in peer interaction patterns occur between males and females in cooperative learning groups as they work with interactive multimedia when the gender composition of the groups is varied, (2) Do any significant differences in attitudes and perceptions toward their cooperative group experience occur between males and females using interactive multimedia when the gender composition of the groups is varied, and (3) Are there any significant correlations among peer interactions and attitudes of males and females working in cooperative groups with interactive multimedia. The independent variables gender and group composition are examined first. Additional findings, based on group composition and school as independent variables, are also presented within each section. The additional results were completed after exploratory analyses revealed significant differences between students from School A and School B. Means, standard deviations, and sample sizes are shown separately for each dependent interaction and attitude variable. A two-way analysis of variance table is presented following the table of means for each dependent variable. The level of significance for all analyses was set at .05.

Peer interaction, the dependent variable of the first research question, is reported by seven categories: (a) total, (b) path/pace, (c) task, (d) socio-emotional, (e) technical, (f) off-task, and (g) uncodable. Total was computed as the sum of the six main interaction categories on the Peer Interaction Scale. Cohen (1994) has suggested that the total frequency of interactions may be an indication of learning for ill-defined tasks. A summary of the results for gender and group composition concludes the section for the first research question. The analysis is repeated with a summary for group composition and school. The interaction data was not always normally distributed. See Appendix G for frequency distributions of the interaction data.

The second research question examines student attitude toward their cooperative group experience. The five categories reported for the dependent variables are: (a) Factor 1, positive emotional reaction to the group, (b) Factor 2, presence of helping behaviors in the group, (c) Factor 3, preference for working alone, (d) Factor 4, lack of helping behaviors in the group, and (e) Factor 5, preference for small-group learning. Each of the five factors was identified through completion of a factor analysis on the attitudinal survey data from both schools, as described in Chapter III. Under Additional Findings, the five attitudinal factors were analyzed by school and group composition.

Data for the third research question are presented in the form of correlations between students' verbal interactions and attitudes. The seven interaction dependent variables were correlated with all five attitudinal factors. A discussion of the independent variables gender, group composition, and school concludes the chapter.

Research Question #1: Peer Verbal Interaction

The first research question asked if significant differences in verbal interactions occurred between males and females in groups of differing gender composition as they worked with interactive multimedia. Interaction was operationalized as the frequency of interactions identified on the Peer Interaction Scale. The means, standard deviations, and sample sizes, gender by group composition, are presented for each dependent peer interaction variable: total interactions, path/pace, task, socio-emotional, technical, off-task, and uncodable. The findings are summarized by gender and group composition at the end of the section.

Total interactions

Total interactions were determined for each student by summing all subtotals for the six main categories from the Peer Interaction Scale: path/pace, task, socio-emotional technical, off-task, and uncodable. The means, standard deviations, and sample sizes for total interactions by gender and group composition are presented in Table 4. The overall mean for the total sample was M=54.63 (n=127). A two-way analysis of variance was done on the data for total interactions. Table 5 presents the results. There were no significant main effects from gender [$F(1,119)=.07$, $p< .793$] or group composition [$F(3,119)=2.53$, $p<.061$], although group does approach significance. The two-way interaction between gender and group composition was not significant [$F(3,119)=.51$, $p<.675$].

Path/pace interactions

Path/pace interactions were those interactions occurring as students made navigational decisions about where to go or how fast to go through the material. The means, standard deviations, and sample sizes for path/pace interactions by gender and group composition are presented in Table 6. The total sample mean for path/pace interactions was M=18.20. The results from a two-way analysis of variance are shown in Table 7. Neither gender [$F(1,119)=1.10$, $p<.297$] nor group composition [$F(3,119)=1.78$, $p< .156$] had a significant effect on path/pace interactions. The two-way interaction was not significant [$F(3,119)=.51$, $p<.678$].

Table 4. Means, standard deviations, and sample sizes for total interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	60.50	49.92	54.73
SD	25.61	18.40	22.08
N	10	12	22
Mostly-male			
Mean	59.66	55.42	58.41
SD	33.72	32.41	32.99
N	29	12	41
Mostly-female			
Mean	47.36	43.27	44.30
SD	28.98	26.14	26.59
N	11	33	44
Equal-gender			
Mean	63.30	75.70	69.50
SD	42.18	44.78	42.81
N	10	10	20
Total			
Mean	58.15	51.48	54.63
SD	32.89	31.02	31.96
N	60	67	127

Table 5. Analysis of variance for total interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	8079.46	4	2019.87	2.05	.092
Gender	68.15	1	68.15	.07	.793
Group	7483.25	3	2494.42	2.53	.061
Two-way Interaction	1512.75	3	504.25	.51	.675
Gender Group	1512.75	3	504.25	.51	.675
Explained	11379.43	7	1625.63	.125	.128
Residual	117342.18	119	986.07		
Total	128721.61	126	1021.60		

Table 6. Means, standard deviations, and sample sizes for path/pace interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	26.40	17.83	21.73
SD	12.15	13.09	13.12
N	10	12	22
Mostly-male			
Mean	16.69	13.92	15.88
SD	12.16	7.32	10.95
N	29	12	41
Mostly-female			
Mean	18.73	15.58	16.36
SD	16.30	16.09	16.01
N	11	33	44
Equal-gender			
Mean	21.90	24.40	23.15
SD	16.70	20.18	18.07
N	10	10	20
Total			
Mean	19.55	17.00	18.20
SD	13.90	15.16	14.58
N	60	67	127

Table 7. Analysis of variance for path/pace interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	1299.79	4	324.95	1.54	.194
Gender	231.04	1	231.04	1.10	.297
Group	1121.55	3	373.85	1.78	.156
Two-way Interaction	320.73	3	106.91	.51	.678
Gender Group	320.73	3	106.91	.51	.678
Explained	1711.95	7	244.56	1.16	.330
Residual	25064.73	119	210.63		
Total	26776.68	126	212.51		

Task interactions

Task interactions focused directly on completion of the questions or development of the project. Means, standard deviation, and sample sizes for task interactions, gender by group composition, are presented in Table 8. The overall mean for the total sample was M=22.40. Table 9 shows the results from an analysis of variance, gender by group composition. A significant main effect was found for group [$F(3,119)=3.39$, $p<.020$] but not for gender [$F(1,119)=.07$, $p<.792$. The effect from group is discussed more completely in Additional Findings. The two-way interaction between gender and group was not significant [$F(3,119)=.31$, $p<.817$].

Socio-emotional interactions

Socio-emotional interactions reflected encouragement or discouragement toward the group or group members; positive, negative, or neutral comments about the program; or joking. Means, standard deviations, and sample sizes for socio-emotional interactions, gender by group composition, are presented in Table 10. The overall mean for the total sample was M=8.94 socio-emotional interactions. A two-way analysis of variance was performed on the socio-emotional interaction data, gender by group, shown in Table 11. Neither gender [$F(1,119)=.04$, $p=.840$] nor group [F $(3,119)=1.48$, $p=.230$] had a significant main effect on socio-emotional interactions. The two-way interaction between gender and group was not significant [F $(3,119)=.21$, $p=.886$].

Technical interactions

Technical interactions related to any hardware of software problems which occurred while students were working with the program. The means, standard

Table 8. Means, standard deviations, and numbers of subjects for task interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	19.70	15.50	17.41
SD	9.49	10.66	10.14
N	10	12	22
Mostly-male			
Mean	26.31	27.67	26.71
SD	19.91	25.79	21.47
N	29	12	41
Mostly-female			
Mean	17.45	18.27	18.07
SD	9.56	10.68	10.31
N	11	33	44
Equal-gender			
Mean	25.90	31.30	28.60
SD	18.71	18.07	18.11
N	10	10	20
Total			
Mean	23.52	21.40	22.40
SD	16.88	16.21	16.50
N	60	67	127

Table 9. Analysis of variance for task interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	2720.87	4	680.22	2.60	.040
Gender	18.30	1	18.30	.07	.792
Group	2659.50	3	886.50	3.39	.020
Two-Way Interaction	244.78	3	81.59	.31	.817
Gender Group	244.78	3	81.59	.31	.817
Explained	3166.27	7	452.33	1.73	.109
Residual	31132.25	119	261.62		
Total	34298.52	126	272.21		

Table 10. Means, standard deviations, and numbers of subjects for socio-emotional interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	10.00	9.25	9.59
SD	7.36	4.56	5.85
N	10	12	22
Mostly-male			
Mean	10.97	9.58	10.56
SD	10.18	7.62	9.43
N	29	12	41
Mostly-female			
Mean	7.27	6.12	6.41
SD	9.86	5.96	7.02
N	11	33	44
Equal-gender			
Mean	9.50	11.50	10.50
SD	7.60	9.56	8.47
N	10	10	20
Total			
Mean	9.88	8.10	8.94
SD	9.20	6.87	8.07
N	60	67	127

Table 11. Analysis of variance for socio-emotional interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	319.08	4	79.77	1.23	.301
Gender	2.65	1	2.65	.04	.840
Group	282.60	3	94.20	1.46	.230
Two-Way Interaction	41.59	3	13.86	.21	.886
Gender Group	41.59	3	13.86	.21	.886
Explained	497.79	7	71.11	1.10	.369
Residual	7704.83	119	64.75		
Total	8202.61	126	65.10		

deviations, and sample sizes are shown in Table 12. The total sample mean was M=.45. The results of a two-way analysis of variance, gender by group composition, are shown in Table 13. There were no significant effects for either gender [F, (1,119)=.47, p=.495] or group [F(3,119)=.14,p=.937]. The two-way interaction between gender and group was not significant [F(3,119)=1.31, p<.275].

Off-task interactions

Off-task interactions occurred when students spoke of something not related to navigating the program, accomplishing the task, or participating in socio-emotional interaction with the group. Means, standard deviations, and sample sizes for off-task interactions, gender by group composition, are presented in Table 14. The overall mean for the total sample for off-task interactions was M=2.27. A two-way analysis of variance, shown in Table 15, reflects no significant main effects for either gender [F(1,119)=1.33, p<.251] or group [F(3,119)=2.34, p<.077]. The two-way interaction between gender and group was not significant either [F(3,119)=1.02, p<.387].

Uncodable interactions

Uncodable interactions included any noise or verbal utterance which the raters could not code. The means, standard deviations, and sample sizes are presented in Table 16. The overall mean was 2.36. Table 17 shows the results of a two-way analysis of variance, gender by group composition. There was not a significant main effect for either gender [F(1,119)=.13, p<.716] or group composition [F(3,119)=1.88, p<.131]. The two-way interaction between gender and group was not significant [F(3,119)=1.33, p<.269].

Table 12. Means, standard deviations, and numbers of subjects for technical interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	.40	.58	.50
SD	.70	1.00	.86
N	10	12	22
Mostly-male			
Mean	.31	.75	.44
SD	.76	1.06	.87
N	29	12	41
Mostly-female			
Mean	.73	.36	.45
SD	.90	.74	.79
N	11	33	44
Equal-gender			
Mean	.30	.50	.40
SD	.95	.97	.94
N	10	10	20
Total			
Mean	.40	.49	.45
SD	.81	.88	.84
N	60	67	127

Table 13. Analysis of variance for technical interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	.70	4	.17	.24	.915
Gender	.34	1	.34	.47	.495
Group	.30	3	.10	.14	.937
Two-Way Interaction	2.84	3	.95	1.31	.275
Gender Group	2.84	3	.95	1.31	.275
Explained	3.23	7	.46	.64	.725
Residual	86.19	119	.72		
Total	89.42	126	.71		

Table 14. Means, standard deviations, and numbers of subjects for off-task interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	1.20	2.67	2.00
SD	1.69	3.85	3.09
N	10	12	22
Mostly-male			
Mean	2.72	1.50	2.37
SD	6.37	2.02	5.46
N	29	12	41
Mostly-female			
Mean	.64	1.73	1.45
SD	1.03	2.32	2.12
N	11	33	44
Equal-gender			
Mean	3.00	5.30	4.15
SD	3.46	5.12	4.42
N	10	10	20
Total			
Mean	2.13	2.39	2.27
SD	4.75	3.32	4.04
N	60	67	127

Table 15. Analysis of variance for off-task interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	124.26	4	31.07	1.95	.107
Gender	21.21	1	21.21	1.49	.251
Group	111.97	3	37.32	2.34	.077
Two-Way Interaction	48.66	3	16.22	1.02	.387
Gender Group	48.66	3	16.22	1.02	.387
Explained	162.65	7	23.24	1.46	.189
Residual	1896.25	119	15.94		
Total	2058.90	126	16.34		

Table 16. Means, standard deviations, and numbers of subjects for uncodable interactions: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	2.80	4.08	3.50
SD	2.44	3.53	3.08
N	10	12	22
Mostly-male			
Mean	2.66	2.00	2.46
SD	2.88	1.86	2.62
N	29	12	41
Mostly-female			
Mean	2.55	1.21	1.55
SD	3.47	1.49	2.19
N	11	33	44
Equal-gender			
Mean	2.70	2.70	2.70
SD	2.16	1.49	1.81
N	10	10	20
Total			
Mean	2.67	2.09	2.36
SD	2.76	2.28	2.53
N	60	67	127

Table 17. Analysis of variance for uncodable interactions: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	35.63	4	8.91	1.48	.212
Gender	.80	1	.80	.13	.716
Group	33.86	3	11.29	1.88	.137
Two-Way Interaction	23.93	3	7.98	1.33	.269
Gender Group	23.93	3	7.98	1.33	.269
Explained	87.83	7	12.55	2.09	.050
Residual	715.51	119	6.01		
Total	803.34	126	6.38		

Summary

The mean score for all subjects (n=127) for a 20-minute segment was 54.63 total interactions. Of the total interactions, 33.3% (M=18.20) were path/pace, 41.0% (M=22.40) were task, 16.4% (M=8.94) were socio-emotional, .8% (M=.45) were technical, 4.2% (M=2.27) were off-task, and 4.3% (M=2.36) were uncodable. Interactions directly related to navigating the program or accomplishing the task (path/pace and task) totaled 74.3%.

Group composition. Group composition had a main effect in only one category: task. This effect is more fully addressed in the next section, Additional Findings for Peer Interactions. Group approached significance in total interactions.

Gender. The independent variable of gender did not show any significant main effects for any of the dependent interaction variables.

Two-way interactions. No two-way interactions for gender or group composition were significant.

Additional Findings for Peer Interactions

This section presents results from further analyses of the data using group composition and school as independent variables with two-way analyses of variance. The significance of school was revealed during exploratory analyses. The statistical procedures were completed with two-way analyses of variance because the cell sizes became too small with three-way analyses. Data are presented by dependent interaction variables: total, path/pace, task, socio-emotional, technical, off-task, and uncodable. Tables are shown for means, standard deviations, and sample sizes and for a two-way analysis of variance for each variable. Results for group composition, school, and two-way interactions are summarized at the end of the section.

Total interactions

Total interactions are the combined total of path/pace, task, socio-emotional, technical, off-task, and uncodable interactions. Means, standard deviations, and sample sizes are presented in Table 18 for total interactions, group by school. The overall mean for the total sample (n=127) for total interactions was M=54.63. A two-way analysis of variance was performed on the data for total interactions, group by school, shown in Table 19. Significant main effects were found for both group [$F(3,119)=3.32$, $p<.022$] and school [$F(1,119)=24.17$, $p<.000$]. Students at School A (M=64.63) scored significantly more total interactions than those at School B (M=44.15). Further group comparisons using the Fisher PLSD test revealed that students in mostly-female groups (M=44.30) scored significantly lower than those in both equal-gender (M=69.50) and mostly-male (58.41) groups. The two-way interaction between group and school was also significant [$F(3,119)=6.27$, $p<.000$]. See Figure 1 in Appendix H for a graphic representation of the interaction.

Path/pace interactions

Path/pace interactions occurred as students navigated through the program. Means, standard deviations, and sample sizes for path/pace interactions, group by school, are presented in Table 20. The mean for the total sample was M=18.20. A two-way analysis of variance was performed on the path/pace interaction data, group by school. Table 21 presents the results. Significant main effects were found for both group [$F(3,119)=3.02$, $p<.032$] and for

Table 18. Means, standard deviations, and sample sizes for total interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	67.83	49.81	54.73
SD	5.78	24.02	22.08
N	6	16	22
Mostly-male			
Mean	81.11	40.65	58.41
SD	29.06	23.98	32.99
N	18	23	41
Mostly-female			
Mean	43.17	46.47	44.30
SD	23.80	32.11	26.59
N	29	15	44
Equal-gender			
Mean	90.17	38.50	69.50
SD	42.83	16.19	42.81
N	12	8	20
Total			
Mean	64.63	44.15	54.63
SD	34.62	25.19	31.96
N	65	62	127

Table 19. Analysis of variance for total interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	24646.49	4	6161.62	8.32	.000
Group	7367.30	3	2455.77	3.32	.022
School	1794.48	1	17904.48	24.17	.000
Two-Way Interaction	13930.31	3	4643.44	6.27	.002
Group School	13930.31	3	4643.44	6.27	.002
Explained	40575.80	7	5796.54	7.83	.000
Residual	88145.80	119	740.72		
Total	128721.61	126	1021.60		

Table 20. Means, standard deviations, and sample sizes for path/pace interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	34.00	17.13	21.73
SD	5.22	12.21	13.12
N	6	16	22
Mostly-male			
Mean	16.00	15.78	15.88
SD	11.13	11.06	10.95
N	18	23	41
Mostly-female			
Mean	18.83	11.60	16.36
SD	18.45	8.36	16.01
N	29	15	44
Equal-gender			
Mean	30.92	11.50	23.15
SD	19.64	4.66	18.07
N	12	8	20
Total			
Mean	21.68	14.56	18.20
SD	17.12	10.25	14.58
N	65	62	127

Table 21. Analysis of variance of path/pace interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	4067.53	4	1016.88	5.48	.000
Group	1682.45	3	560.82	3.02	.032
School	2999.76	1	2999.76	16.17	.000
Two-Way Interaction	1585.00	3	528.34	2.85	.040
Group School	1585.00	3	528.34	2.85	.040
Explained	4702.36	7	671.77	3.62	.001
Residual	22074.32	119	185.50		
Total	26776.68	126	212.51		

school [F(1,119)=16.17, p<.000]. Students in School A (M=21.68) had more path/pace interactions than those at School B (M=14.56). A Fisher PLSD test failed to reveal any significant differences between groups. The two-way interaction between group and school was significant [F(3,119)=2.85, p<.040]. See Figure 2 in Appendix H for a graphic representation of the interaction.

Task interactions

Task interactions occurred when students attempted to answer questions, discussed the subject matter, or developed their projects. The means, standard deviations, and sample sizes for task interactions are presented in Table 22. The overall mean for the total sample was M=22.40 for task interactions. A two-way analysis of variance was performed on the task interaction data, group composition by school. The results are presented in Table 23. Significant main effects were found for both group [F(3,119)=5.83, p<.001] and school [F(1,119)=16.48, p<.000]. Students in School A (M=27.58) had a higher number of interactions than those at School B (M=16.97). Further comparisons among groups using the Fisher protected least significance difference test revealed significant differences among the groups. Students in equal-gender groups (M=28.60) and mostly-male (M=26.71) had significantly higher task interactions than those in mostly-female (M=18.07) and same-gender (M=17.41). The two-way interaction between group and school also was significant [F(3,119)=12.89, p<.000]. See Figure 3 in Appendix H for a graphic representation of the interaction. Students in equal-gender groups (M=28.60) scored the highest average for task interactions. However, students in same-gender groups (M=17.41) had the least. Students in mostly-male groups (M=42.11) had the highest number of task interaction among males at School A, and those in same-gender groups

Table 22. Means, standard deviations, and sample sizes for task interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	12.67	19.19	17.41
SD	10.88	9.59	10.14
N	6	16	22
Mostly-male			
Mean	42.11	14.65	26.71
SD	22.00	10.84	21.47
N	18	23	41
Mostly-female			
Mean	17.21	19.73	18.07
SD	8.26	13.62	10.31
N	29	15	44
Equal-gender			
Mean	38.33	14.00	28.60
SD	16.36	8.00	18.11
N	12	8	20
Total			
Mean	27.58	16.97	22.40
SD	19.09	11.02	16.50
N	65	62	127

Table 23. Analysis of variance for task interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	6787.38	4	1696.84	9.76	.000
Group	3041.85	3	1013.95	5.83	.001
School	2865.27	1	2865.27	16.48	.000
Two-Way Interaction	6723.39	3	2241.13	12.89	.000
Group School	6723.39	3	2241.13	12.89	.000
Explained	13607.40	7	1943.91	11.18	.000
Residual	20691.13	119	173.88		
Total	34298.52	126	272.21		

(M=12.67) had the least. At School B students in mostly-female groups (M=19.73) had the highest average and those in equal-gender groups (M=14.00) had the least.

Socio-emotional interactions

Socio-emotional interactions included encouraging and discouraging remarks, positive and negative comments about the program, general comments, and joking. The means, standard deviations, and sample sizes for socio-emotional interactions are shown in Table 24. The overall mean for the total sample was M=8.94. A two-way analysis of variance was done on the socio-emotional interactions, group composition by school. Table 25 presents the results. A significant main effect was not found for group [$\underline{F}(3,119)=1.85$, $p<.141$]. However, a significant main effect was found for school [$\underline{F}(3,119)=4.50$, $p<.036$]. The students at School A (M=9.74) averaged more interactions than those at School B (M=8.11). The two-way interaction between group and school also was significant [$\underline{F}(3,119)=6.35$, $p<.000$]. See Figure 4 in Appendix H for a graphic representation of the interaction.

Technical interactions

Technical interactions were tallied when students asked questions or gave information about any hardware or software problems which occurred while they worked with the program. The means, standard deviations, and sample sizes for technical interactions are presented in Table 26. The overall mean for the total sample was M=.45. A two-way analysis of variance was performed on the data for technical interactions. Table 27 shows the results. No significant main effects were found for group [$\underline{F}(3,119)=.70$,$p<.555$] or school

Table 24. Means, standard deviations, and sample sizes for socio-emotional interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	12.00	8.69	9.59
SD	2.45	6.54	5.85
N	6	16	22
Mostly-male			
Mean	15.11	7.00	10.56
SD	10.89	6.30	9.43
N	18	23	41
Mostly-female			
Mean	4.52	10.07	6.41
SD	2.50	10.82	7.02
N	29	15	44
Equal-gender			
Mean	13.17	6.50	10.50
SD	9.92	3.12	8.47
N	12	8	20
Total			
Mean	9.74	8.11	8.94
SD	8.65	7.39	8.07
N	65	62	127

Table 25. Analysis of variance of socio-emotional interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	484.52	4	121.13	2.21	.072
Group	305.00	3	101.67	1.85	.141
School	246.63	1	246.63	4.50	.036
Two-Way Interaction	1044.69	3	348.23	6.35	.000
Group School	1044.69	3	348.23	6.35	.000
Explained	1677.56	7	239.65	4.37	.000
Residual	6525.06	119	54.83		
Total	8202.61	126	65.10		

Table 26. Means, standard deviations, and sample sizes for technical interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	1.33	.19	.50
SD	1.03	.54	.86
N	6	16	22
Mostly-male			
Mean	.50	.39	.44
SD	.79	.94	.87
N	18	23	41
Mostly-female			
Mean	.41	.53	.45
SD	.78	.83	.79
N	29	15	44
Equal-gender			
Mean	.33	.50	.40
SD	.89	1.07	.94
N	12	8	20
Total			
Mean	.51	.39	.45
SD	.85	.84	.84
N	65	62	127

Table 27. Analysis of variance for technical interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	2.31	4	.56	.83	.511
Group	1.46	3	.49	.70	.555
School	1.47	1	1.47	2.10	.150
Two-Way Interaction	5.54	3	1.85	2.64	.052
Group School	5.54	3	1.85	2.64	.052
Explained	6.23	7	.89	1.27	.269
Residual	83.18	119	.70		
Total	89.42	126	.71		

[F1,119)=2.10,p<.150]. The two-way interaction approached significance [F(3,119)=2.64, p<.052].

Off-task interactions

Off-task interactions occurred when students made comments or asked questions that were not relevant to the learning task or program. The means, standard deviations, and sample sizes for off-task interactions are shown in Table 28. The mean for the total sample was M=2.27 off-task interactions for the observation time. A two-way analysis of variance was done on the off-task interaction data. Table 29 presents the results. A significant main effect was not found for group [F(3,119)=1.63, p<.187]. However, a significant main effect was found for school [F(1,119)=7.93, p<.006]. The average interaction frequency for School A (M=3.12)was significantly higher than for School B (M=1.37). The two-way interaction between group and school was also significant [F(3,119)-3.63, p<.015]. See Figure 5 in Appendix H for a graphic representation of the interaction.

Uncodable interactions

Uncodable interactions included meaningless noises and utterances which were too quiet to distinguish. The means, standard deviations, and sample sizes for uncodable interactions are presented in Table 30. The mean for the total sample for uncodable interactions was M=2.36. A two-way analysis of variance was done on the uncodable interaction data. The results are presented in Table 31. No significant main effects were found for group [F(3,119)=2.39, p<.072] or for school [F(1,119)=.68, p<.412]. The two-way interaction between group and school was not significant [F(3,119)=.575, p<.525].

Table 28. Means, standard deviations, and sample sizes for off-task interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	4.17	1.19	2.00
SD	4.96	1.60	3.09
N	6	16	22
Mostly-male			
Mean	4.78	.48	2.37
SD	7.64	.85	5.46
N	18	23	41
Mostly-female			
Mean	1.07	2.20	1.45
SD	1.53	2.86	2.12
N	29	15	44
Equal-gender			
Mean	5.08	2.75	4.15
SD	5.28	2.31	4.42
N	12	8	20
Total			
Mean	3.12	1.37	2.27
SD	5.17	2.03	4.04
N	65	62	127

Table 29. Analysis of variance for off-task interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	190.30	4	47.58	3.34	.012
Group	69.35	3	23.12	1.63	.187
School	112.79	1	112.79	7.93	.006
Two-Way Interactions	154.91	3	51.64	3.63	.015
Group School	154.91	3	51.64	3.63	.015
Explained	366.10	7	52.30	3.68	.001
Residual	1692.80	119	14.23		
Total	2058.90	126	16.34		

Table 30. Means, standard deviations, and sample sizes for uncodable interactions: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	3.67	3.44	3.50
SD	1.97	3.46	3.08
N	6	16	22
Mostly-male			
Mean	2.61	2.35	2.46
SD	3.36	1.92	2.62
N	18	23	41
Mostly-female			
Mean	1.14	2.33	1.55
SD	1.36	3.18	2.19
N	29	15	44
Equal-gender			
Mean	2.33	3.25	2.70
SD	2.06	1.28	1.81
N	12	8	20
Total			
Mean	2.00	2.74	2.36
SD	2.36	2.65	2.53
N	65	62	127

Table 31. Analysis of variance for uncodable interactions: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	58.88	4	14.72	2.42	.052
Group	43.64	3	14.55	2.39	.072
School	4.11	1	4.11	.68	.412
Two-Way Interaction	13.68	3	4.56	.75	.525
Group School	13.68	3	4.56	.75	.525
Explained	79.62	7	11.38	1.87	.080
Residual	723.71	119	6.08		
Total	803.34	126	6.38		

Summary

Two-way analyses of variance were completed on the interaction data using group composition and school as independent variables after exploratory analyses showed a significant effect from school.

Group Composition. The variable of group composition showed significant main effects for three interaction categories: total, path/pace, and task. For total interactions, mostly-female scored significantly lower than both equal-gender and mostly-male groups. For task interactions, both equal-gender and mostly-male groups scored significantly higher than both mostly-female and same-gender.

School. The independent variable of school significantly affected five interaction categories: total, path/pace, task, socio-emotional, and off-task. Students at School A average significantly higher frequencies than those at School B in these five categories.

Two-way interactions. Significant two-way interactions occurred in five categories: total, path/pace, task, socio-emotional, and off-task. For total, socio-emotional, and off-task interactions, mostly-female groups at School A scored more consistently with School B groups than others at their school. For task interactions, both same-gender and mostly-female groups scored closer to the range of frequencies for groups at School B. See Appendix H for Figures 1 though 5 which graphically represent the significant two-way interactions between group and school for total, path/pace, task, socio-emotional, and off-task variables.

Research Question #2: Attitude

The second research question asked whether significant differences between males and females occurred in attitude toward cooperative learning experiences when they were assigned to groups of varying gender composition. The general attitude score was measured by their mean score on the attitudinal survey. A higher score indicated a more positive attitude toward the cooperative learning experience with *Loess Hills Interactive*. As described in Chapter III, a factor analysis, completed on the survey data, identified five factors: Factor 1, positive emotional reaction to the group; Factor 2, presence of helping behaviors in the group; Factor 3, preference for working alone; Factor 4, lack of helping behaviors in the group; and Factor 5, preference for small-group learning. These five factors are reported as dependent variables in this section.

Factor 1, positive emotional reaction to the group

The first dependent variable, Factor 1, positive emotional reaction to the group, was obtained from the factor analysis. Table 32 presents the means, standard deviations, and sample sizes for Factor 1. The overall mean for the total sample was $M=4.66$. A two-way analysis of variance was done on the data for Factor 1 using gender and group composition as independent variables. The results are presented in Table 33. There were no significant main effects for gender [$F(1,118)=.03$, $p<.861$] or group [$F(3,118)=1.69$, $p<.172$]. The two- way interaction between gender and group also was not significant [$F(3,118)=1.10$, $p<.353$].

Table 32. Means, standard deviations, and sample sizes for Factor 1, positive emotional reaction to the group: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	4.90	4.78	4.83
SD	.83	.92	.86
N	10	12	22
Mostly male			
Mean	4.57	4.04	4.42
SD	1.09	1.04	1.09
N	29	12	41
Mostly female			
Mean	4.77	4.77	4.77
SD	.68	1.15	1.04
N	11	33	44
Equal-gender			
Mean	4.48	5.00	4.73
SD	1.24	.62	1.00
N	10	9	19
Total			
Mean	4.65	4.67	4.66
SD	1.00	1.06	1.03
N	60	66	126

Table 33. Analysis of variance for Factor 1, positive emotional reaction to the group: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	5.50	4	1.37	1.30	.273
Gender	.03	1	.03	.03	.861
Group	5.35	3	1.78	1.69	.172
Two-Way Interaction	3.47	3	1.16	1.10	.353
Gender Group	3.47	3	1.16	1.10	.353
Explained	7.42	7	1.06	1.01	.431
Residual	124.33	118	1.05		
Total	131.74	125	1.05		

Factor 2, presence of helping behaviors in the group

Factor 2, the presence of helping behaviors in the group, was determined from the factor analysis of the attitudinal survey data. The means, standard deviations, and sample sizes for Factor 2 are presented in Table 34. The mean for the total sample was M=4.68. A two-way analysis of variance was completed on the Factor 2 data, gender by group composition. Table 35 presents the results. No significant main effects were found for either gender [$F(1,118)=1.11$, $p<.294$] or group [$F(3,118)=.46$, $p<.712$]. The two-way interaction was not significant [$F(3,118)=.31$, $p<.820$].

Factor 3, preference for working alone

Factor 3, preference for working alone, was obtained from the factor analysis on the survey data. The means, standard deviations, and sample sizes for Factor 3, gender by group composition, are shown in Table 36. The overall mean for the total sample was M=2.65. A two-way analysis of variance was done for the Factor 3 data, gender by group composition. The results are presented in Table 37. No significant main effects were found for gender [$F(1,118)=1.08$, $p<.302$] or for group [$F(3,118)=1.88$, $p<.138$]. The two-way interaction between gender and group was not significant [$F(3,119)=.57$, $p<.638$].

Factor 4, lack of helping behaviors in the group

Factor 4, lack of helping behaviors in the group, was derived from the factor analysis. The means, standard deviations, and sample sizes for Factor 4 are presented in Table 38. The overall mean for the total sample was M=2.06. A two-way analysis of variance was performed with the data from Factor 4, gender by group composition. The results are presented in Table 39. Neither gender

Table 34. Means, standard deviations, and sample sizes for Factor 2, presence of helping behaviors in the group: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	4.48	4.69	4.59
SD	1.15	.66	.90
N	10	12	22
Mostly male			
Mean	4.74	4.73	4.73
SD	.87	.86	.86
N	29	12	41
Mostly female			
Mean	4.70	4.79	4.77
SD	.61	1.10	.99
N	11	33	44
Equal-gender			
Mean	4.25	4.72	4.47
SD	.58	.84	.74
N	10	9	19
Total			
Mean	4.61	4.75	4.68
SD	.84	.94	.89
N	60	66	126

Table 35. Analysis of variance for Factor 2, presence of helping behaviors in the group: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	2.21	4	.55	.67	.614
Gender	.92	1	.92	1.11	.294
Group	1.13	3	.38	.46	.712
Two-Way Interaction	.76	3	.25	.31	.820
Gender Group	.76	3	.25	.31	.820
Explained	2.80	7	.40	.49	.844
Residual	97.14	118	.82		
Total	99.93	125	.80		

Table 36. Means, standard deviations, and sample sizes for Factor 3, preference for working alone: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	3.07	3.33	3.21
SD	1.28	1.39	1.32
N	10	12	22
Mostly-male			
Mean	2.94	2.31	2.76
SD	1.33	1.07	1.28
N	29	12	41
Mostly-female			
Mean	2.58	2.23	2.32
SD	1.42	1.13	1.21
N	11	33	44
Equal-gender			
Mean	2.67	2.33	2.51
SD	1.43	1.19	1.30
N	10	9	19
Total			
Mean	2.85	2.46	2.65
SD	1.34	1.23	1.29
N	60	66	126

Table 37. Analysis of variance for Factor 3, preference for working along: Gender by group composition

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	11.34	4	2.87	1.76	.141
Gender	1.73	1	1.73	1.08	.302
Group	9.05	3	3.02	1.88	.138
Two-Way Interaction	2.73	3	.91	.57	.638
Gender Group	2.73	3	.91	.57	.638
Explained	17.97	7	2.57	1.60	.143
Residual	189.76	118	1.61		
Total	207.72	125	1.66		

Table 38. Means, standard deviations, and sample sizes for Factor 4, lack of helping behaviors in the group: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	2.10	2.33	2.23
SD	1.31	1.59	1.44
N	10	12	22
Mostly-male			
Mean	1.98	1.88	1.95
SD	1.00	.77	.93
N	29	12	41
Mostly-female			
Mean	2.50	2.05	2.16
SD	1.41	1.18	1.24
N	11	33	44
Equal-gender			
Mean	2.25	1.50	1.89
SD	.49	.61	.66
N	10	9	19
Total			
Mean	2.14	1.99	2.06
SD	1.07	1.15	1.11
N	60	66	126

Table 39. Analysis of variance for Factor 4, lack of helping behavior in the group: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	4.08	4	1.02	.82	.514
Gender	1.84	1	1.84	1.48	.226
Group	3.20	3	1.07	.86	.464
Two-Way Interaction	2.97	3	.99	.80	.498
Gender Group	2.97	3	.99	.80	.498
Explained	6.82	7	.97	.78	.603
Residual	146.68	118	1.24		
Total	153.49	125	1.23		

[F(1,118)=1.48, p<.226] nor group [F(3,118)=.86, p<.464] had significant main effects. The two-way interaction between gender and group [F(3,118)=.80, p<.498] was not significant.

Factor 5, preference for small-group learning

Factor 5 represents preference for small-group learning. Means, standard deviations, and sample sizes for Factor 5, gender by group composition are presented in Table 40. The mean for the total sample was M=4.88. A two-way analysis of variance was performed on the Factor 5 data, gender by group composition. The results are presented in Table 41. The main effects for group [F(1,118)=2.26, p<.135] or group [F(3,118)=1.75, p<.161] were not significant. The two-way interaction between gender and group [F(3,118)=.72, p<.545] was not significant.

Summary

The results are summarized by the two independent variables in research question #2: gender and group composition. The dependent variables for attitude included: (1) Factor 1, positive emotional reaction to the group; (2) Factor 2, presence of helping behaviors in the group; (3) Factor 3, preference for working alone; (4) Factor 4, lack of helping behaviors in the group; and (5) Factor 5, preference for small-group learning.

Gender: No significant differences were found in any of the dependent variables for gender.

Group composition. No significant differences were found in any of the dependent variables for group composition.

Table 40. Means, standard deviations, and sample sizes for Factor 5, preference for small-group learning: Gender by group composition.

Group Composition	Males	Females	Total
Same-gender			
Mean	4.85	4.71	4.77
SD	.63	.96	.81
N	10	12	22
Mostly-male			
Mean	4.66	5.04	4.77
SD	1.25	.69	1.12
N	29	12	41
Mostly-female			
Mean	5.05	5.24	5.19
SD	.69	.70	.69
N	11	33	44
Equal-gender			
Mean	4.20	4.89	4.53
SD	1.27	.99	1.17
N	10	9	19
Total			
Mean	4.68	5.06	4.88
SD	1.09	.80	.97
N	60	66	126

Table 41. Analysis of variance for Factor 5, preference for small-group learning: Gender by group composition.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	8.25	4	2.06	2.31	.062
Gender	2.02	1	2.02	2.26	.135
Group	4.68	3	1.56	1.75	.161
Two-Way Interaction	1.91	3	.64	.72	.545
Gender Group	1.91	3	.64	.72	.545
Explained	11.40	7	1.63	1.83	.089
Residual	105.31	118	.89		
Total	116.71	125	.93		

Additional Findings for Attitude

Exploratory statistical analyses revealed school to be a significant independent variable on the data results. Further two-way analyses of variance were performed using group composition and school as the two independent variables. Separate tables of means and two-way analyses of variance are presented for each dependent attitude variable: Factor 1, positive emotional reaction to the group, Factor 2, presence of helping behaviors, Factor 3, preference for working alone, Factor 4, lack of helping behaviors in the group, and Factor 5, preference for small-group learning. The results are summarized for each variable at the end of the section.

Factor 1, positive emotional reaction to the group

Factor 1, positive emotional reaction to the group, was obtained from the factor analysis performed with the data from the attitudinal survey. The means, standard deviations, and sample sizes for Factor 1, group composition by school, are presented in Table 42. The overall mean for the total sample was M=4.66. A two-way analysis of variance was performed on the data for Factor 1, group composition by school. The results are presented in Table 43. The main effect for group was not significant [$F(3,118)=1.05$, $p<.373$]. However, the main effect for school was significant [$F(1,118)=7.35$, $p<.008$]. Students from School A (M=4.94) scored higher than those from School B (M=4.36) on positive emotional reactions toward their groups. The two-way interaction between group and school was not significant [$F(3,118)=1.63$, $p<.186$].

Table 42. Means, standard deviations, and sample sizes for Factor 1, positive emotional reaction to the group: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	5.11	4.73	4.83
SD	.98	.83	.86
N	6	16	22
Mostly-male			
Mean	4.59	4.28	4.42
SD	.89	1.23	1.09
N	18	23	41
Mostly-female			
Mean	5.17	4.00	4.77
SD	.49	1.38	1.04
N	29	15	44
Equal-gender			
Mean	4.83	4.55	4.73
SD	1.16	.69	1.00
N	12	7	19
Total			
Mean	4.94	4.36	4.66
SD	.83	1.14	1.03
N	65	61	126

Table 43. Analysis of variance of Factor 1, positive emotional reaction to the group: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	9.42	4	2.36	2.47	.049
Group	3.01	3	1.00	1.05	.373
School	7.01	1	7.01	7.35	.008
Two-Way Interaction	4.67	3	1.56	1.63	.186
Group School	4.67	3	1.56	1.63	.186
Explained	19.08	7	2.73	2.86	.009
Residual	112.67	118	.96		
Total	131.74	125	1.05		

Factor 2, presence of helping behaviors in the group

Factor 2, presence of helping behaviors in the group, was obtained from the factor analysis on the attitudinal survey data. The means, standard deviations, and sample sizes for Factor 2, group composition by school, are shown in Table 44. The overall mean for the total sample was M=4.68. A two-way analysis of variance was performed on the Factor 2 data, group by school. The results are presented in Table 45. No significant main effects were found for group [$F(3,118)=.46$, $p<.714$] or school [$F(1,118)=2.65$, $p<.107$]. The two-way interaction between group and school was not significant [$F(3,118)=1.03$, $p<.380$].

Factor 3, preference for working alone

Factor 3, preference for working along, was derived from the factor analysis on the attitudinal data. Table 46 presents the means, standard deviations, and sample sizes for Factor 3. The overall mean for the total sample was M=2.65. A two-way analysis of variance was performed on the data for Factor 3. The results are presented in Table 47. No significant main effects were found for group [$F(3,118)=1.14$, $p<.338$] or school [$F(1,118)=.93$, $p<.338$]. The two-way interaction was also not significant [$F(3,118)=1.66$, $p<.179$].

Factor 4, lack of helping behaviors in the group

Factor 4, lack of helping behaviors in the group, was obtained from the factor analysis on the attitudinal survey data. The means, standard deviations, and sample sizes for Factor 4 are presented in Table 48. The overall mean for the total sample was M=2.06. A two-way analysis of variance was completed for the data for Factor 4. Table 49 presents the results. There were no significant main

Table 44. Means, standard deviations, and sample sizes for Factor 2, presence of helping behaviors in the group: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	4.63	4.58	4.59
SD	1.22	.79	.90
N	6	16	22
Mostly-male			
Mean	4.89	4.61	4.73
SD	.70	.96	.86
N	18	23	41
Mostly-female			
Mean	5.03	4.27	4.77
SD	.68	1.31	.99
N	29	15	44
Equal-gender			
Mean	4.50	4.43	4.47
SD	.87	.49	.74
N	12	7	19
Total			
Mean	4.86	4.50	4.68
SD	.79	.97	.89
N	65	61	126

Table 45. Analysis of variance for Factor 2, presence of helping behaviors in the group: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	3.08	4	.77	.99	.417
Group	1.06	3	.36	.46	.714
School	2.06	1	2.06	2.65	.107
Two-Way Interaction	2.42	3	.81	1.03	.380
Group School	2.42	3	.81	1.03	.380
Explained	7.99	7	1.14	1.46	.187
Residual	91.95	118	.78		
Total	99.93	125	.80		

Table 46. Means, standard deviations, and sample sizes for Factor 3, preference for working alone: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	2.50	3.48	3.21
SD	1.09	1.33	1.32
N	6	16	22
Mostly-male			
Mean	2.87	2.67	2.76
SD	1.36	1.24	1.28
N	18	23	41
Mostly-female			
Mean	2.10	2.73	2.32
SD	1.00	1.48	1.21
N	29	15	44
Equal-gender			
Mean	2.67	2.24	2.51
SD	1.54	.74	1.30
N	12	7	19
Total			
Mean	2.46	2.85	2.65
SD	1.24	1.32	1.29
N	65	61	126

Table 47. Analysis of variance for Factor 3, preference for working alone: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	9.85	4	2.40	1.52	.200
Group	5.36	3	1.79	1.14	.338
School	1.46	1	1.46	.93	.338
Two-Way Interaction	7.85	3	2.62	1.66	.179
Group School	7.85	3	2.62	1.66	.179
Explained	21.97	7	3.14	1.99	.062
Residual	185.75	118	1.57		
Total	207.72	125	1.66		

Table 48. Means, standard deviations, and sample sizes for Factor 4, lack of helping behaviors in the group: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	2.92	1.97	2.23
SD	1.96	1.16	1.44
N	6	16	22
Mostly-male			
Mean	1.78	2.09	1.95
SD	.69	1.07	.93
N	18	23	41
Mostly-female			
Mean	1.90	2.67	2.16
SD	1.07	1.41	1.24
N	11	15	44
Equal-gender			
Mean	1.83	2.00	1.89
SD	.62	.76	.66
N	12	7	19
Total			
Mean	1.95	2.19	2.06
SD	1.05	1.17	1.11
N	65	61	126

Table 49. Analysis of variance for Factor 4, lack of helping behaviors in the group: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	5.52	4	1.38	1.16	.333
Group	5.00	3	1.67	1.40	.247
School	.14	1	.14	.11	.737
Two-Way Interaction	9.00	3	3.00	2.52	.061
Group School	9.00	3	3.00	2.52	.061
Explained	12.92	7	1.85	1.55	.157
Residual	140.57	118	1.19		
Total	153.49	125	1.23		

effects for either group [$F(3,188)=1.40$, $p<.737$] or school [$F(1,118)=.11$, $p<.737$]. However, the two-way interaction approached significance [$F(3,118)=2.52$, $p<.061$].

Factor 5, preference for small-group learning

Factor 5, preference for small-group learning, was derived from the factor analysis performed on the data from the attitudinal survey. The means, standard deviations, and sample sizes are presented in Table 50. The mean for Factor 5 by the total sample was M=4.88. A two-way analysis of variance was completed on the data for Factor 5. The results are shown in Table 51. A significant main effect was found for group composition [$F(3,188)=2.72$, $p<.048$]. Further comparisons using a Fisher PLSD test showed that mostly-female groups (M=5.30) averaged significantly higher than both equal-gender (M=4.53) and mostly-male (M=4.77) groups. A significant main effect was not found for school [$F(1,118)=.60$, $p<.439$]. The two-way interaction [$F(3,118)=.56$, $p<.642$] was not significant.

Summary

Additional two-way analyses of variance were performed using group composition and school as the two independent variables. The five attitude variables included: Factor 1, positive emotional reaction to the group, Factor 2, presence of helping behaviors in the group, Factor 3, preference for working alone, Factor 4, lack of helping behaviors in the group, and Factor 5, preference for small-group learning.

Group composition. No significant main effects were found for group composition for Factor 1, Factor 2, Factor 3, or Factor 4. However, a significant

Table 50. Means, standard deviations, and sample sizes for Factor 5, preference for small-group learning: Group composition by school.

Group Composition	School A	School B	Total
Same-gender			
Mean	5.17	4.63	4.77
SD	.82	.79	.81
N	6	16	22
Mostly-male			
Mean	4.81	4.74	4.77
SD	.79	1.34	1.12
N	18	23	41
Mostly-female			
Mean	5.14	5.30	5.19
SD	.57	.90	.69
N	29	15	44
Equal-gender			
Mean	4.58	4.43	4.53
SD	1.29	1.02	1.17
N	12	7	19
Total			
Mean	4.95	4.81	4.88
SD	.83	1.09	.97
N	65	61	126

Table 51. Analysis of variance for Factor 5, preference for small-group learning: Group composition by school.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig of F
Main Effects	8.11	4	2.03	2.23	.070
Group	7.43	3	2.48	2.72	.048
School	.55	1	.55	.60	.439
Two-Way Interaction	1.54	3	.512	.56	.642
Group School	1.54	3	.512	.56	.642
Explained	9.15	7	1.31	1.43	.198
Residual	107.57	118	.91		
Total	116.71	125	.93		

main effect for group composition was found for Factor 5, preference for small-group learning. Student in mostly-female groups scored significantly higher than those in equal-gender and mostly-male groups.

School. Significant main effects for school were found for Factor 1, positive emotional reaction to the group. Students at School A had a significantly more positive emotional reaction to their groups than those at School B.

Two-way interactions. There were no significant two-way interactions between group composition and school for any dependent attitude measures.

Research Question #3: Peer Verbal Interactions and Attitudes

Research question #3 asked if any significant correlations occurred among the dependent peer verbal interaction variables and dependent attitude variables. Pearson product-moment correlation coefficients were obtained between all dependent interaction (total, path/pace, task, socio-emotional, technical, off-task, uncodable) and attitude (positive emotional reaction to the group, presence of helping behaviors in the group, preference for working alone, lack of helping behaviors in the group, preference for small-group learning) variables. The correlation coefficients are presented in Table 52. No significant correlations were found among the interaction variables and attitude variables. The only significant correlations were within the interaction variables and within the attitudinal variables.

Table 52. Correlation coefficients: Interactions and attitudes

		Toi	Pai	Tai	Sei	Tei	Oti	Uni	Fa1	Fa2	Fa3	Fa4
Interactions:	Total (Toi)											
	Path (Pai)	.70**										
	Task (Tai)	.76**	.22*									
	Socio (Sei)	.78**	.33**	.51**								
	Tech (Tei)	.17	.11	-.09	.29**							
	Offtask (Oti)	.51**	.31**	.12	.52**	.27**						
	Uncod (Uni)	.31**	.08	.00	.46**	.34**	.50**					
Attitudes:	Factor1 (Fa1)	.03	.01	-.05	.03	.10	.08	-.01				
	Factor2 (Fa2)	.02	.07	-.06	.02	.17	-.01	.07	.56**			
	Factor3 (Fa3)	.14	.08	.20*	.07	-.01	-.08	-.02	-.34**	-.09		
	Factor4 (Fa4)	.02	.06	-.07	.05	.01	.08	.09	-.44**	-.43**	.30**	
	Factor5 (Fa5)	-.01	.02	-.11	.06	.12	.14	.04	.50**	.28**	-.45**	-.20**

*p<.05
**p<.01

Summary

A summary of the results is presented by research question.

(a) Do any significant differences in interactions occur between males and females in cooperative learning groups working with interactive multimedia when the gender composition is varied? Using a two-way analysis of variance with gender and group composition as the independent variables, the researcher found no significant differences for six of the seven dependent interaction variables: total, path/pace, task, socio-emotional, technical, off-task, and uncodable. A significant main effect for group was found for task interactions. None of the two-way interactions were significant.

(b) Additional statistical analyses on the interaction data were performed using school and group composition as independent variables. Equal-gender and mostly-male groups scored significantly higher than mostly-female groups for total interactions. The same two groups scored significantly higher than mostly-female and same-gender for task interactions. School had significant effects on total, path/pace, task, socio-emotional, and off-task interactions. For these five interaction categories, students at School A had significantly more interactions than students at School B. There were also significant two-way interactions for total, path/pace, task, socio-emotional, and off-task interactions.

(c) Do any significant differences in attitudes toward their cooperative learning experience occur between males and females using interactive multimedia when the gender composition of the groups is varied? A factor analysis identified five factors from the survey data: Factor 1, positive emotional reaction to the group, Factor 2, presence of helping behaviors in the group, Factor 3, preference for working alone, Factor 4, lack of helping behaviors in the group, and Factor 5, preference for small-group learning. Two-way analyses of variance were done using gender and group composition as independent variables for the general attitude and each factor. No significant main effects were found for gender or group composition. The two-way interactions were not significant.

(d) Additional statistical analyses on the attitudinal data were done using group composition and school as the two independent variables. Mostly-female groups had a higher preference for small-group learning. Students in School A had significantly more positive emotional reactions to their groups than those at School B. No two-way interactions were significant.

(e) Are there any significant correlations between the interactions and the attitudes? No significant correlations between the interactions and attitudes were found. The only significant correlations were among the interactions and among the attitude scores.

To summarize, interaction and attitudinal data were analyzed both by gender and group gender composition and then by group gender composition and school. Dependent interaction variables included: total, path/pace, task, socio-emotional, technical, off-task, and uncodable. Attitudinal variables included: positive emotional reaction to the group, presence of helping behaviors in the group, preference for working alone, lack of helping behaviors in the group, and preference for small-group learning. No significant differences were found for gender for any dependent interaction or attitude variable. A significant effect for group composition was found on total, path/pace, and task interactions and for Factor 5, preference for small-group learning. Students at School A had significantly higher total, path/pace, task, socio-emotional, and off-task interactions than those at School B.

CHAPTER V. OVERVIEW, DISCUSSION, AND RECOMMENDATIONS

This chapter presents an overview of the study followed by a discussion of the study results. The discussion is organized around the three research questions posed in Chapter I. Recommendations are made for implementing interactive multimedia in the classroom. The chapter concludes with recommendations for further study and a final summary of the study.

Overview of the Study

Previous research suggests that gender and gender group composition may significantly affect peer interaction and attitudes among cooperatively grouped students. The majority of research in this area has been conducted in traditional contexts or with problem-solving or CBI programs. This study proposed to examine peer interactions and attitudes of students using an IRLE-type of interactive multimedia. The questions focused on the verbal interactions and attitudes toward their cooperative learning experience of males and females, working with interactive multimedia in groups of varying gender composition.

One hundred twenty-seven middle school science students (60 males, 67 females) from two Iowa schools participated in the study. Students were randomly assigned to a cooperative learning group with one of these gender compositions: (a) same-gender, (b) mostly-male; (c) mostly-female, or (d) equal-gender. Groups worked with the program, *Loess Hills Interactive,* for up to three sessions over a four week period. Student tasks included answering worksheet questions, responding to on-screen questions, and developing a multimedia presentation.

Groups were videotaped as they used the program. Trained raters coded and tallied the interactions for each individual student from the video tapes, using a Peer Interaction Scale developed from pilot study data (Adamson, 1997). The interaction categories included: (a) total, (b) path/pace, (c) task, (d) socio-emotional, (e) technical, (f) off-task, and (g) uncodable. An attitudinal survey, developed as part of the same pilot study, was administered after students finished using the program. A factor analysis on the survey data identified five attitudinal factors: (1) positive emotional reaction to the group, (2) presence of helping behaviors in the group, (3) preference for working alone, (4) lack of helping behaviors in the group, and (5) preference for small-group learning. Two-way analyses of variance were performed on the verbal interaction and attitudinal data to determine any significant differences between males and females in the cooperative groups of varying gender composition. Further analyses examined the effect of school on interactions and attitudes. Pearson product-moment correlations coefficients were computed on the interaction and attitudinal data to determine any significant correlations among them.

Discussion of the Study Results

Discussion of the results was organized by the three research questions presented in Chapter I. (1) Do any significant differences in verbal interaction patterns occur between males and females in cooperative learning groups as they work with interactive multimedia when the gender composition of the groups is varied? (2) Do any significant differences in attitudes toward their cooperative learning experience occur between males and females using interactive multimedia when the gender composition of the groups is varied? (3) Are there any significant correlations between verbal interactions and attitudes or perceptions toward the cooperative learning experience of males and females working with interactive multimedia?

Several factors concerning the interactive multimedia program, *Loess Hills Interactive*, and the data analysis may have influenced the study results. First, the program was a pilot version under evaluation by the developers. It was not fully field tested before use in the research. Technical difficulties in the delivery of the program over the fiber optic network caused interruptions in the students' scheduled sessions and required adult intervention to solve the problems. Second, the subject matter of the program may have had special interest to the subjects. The Loess Hills are located in Iowa, the students' home state. Some students had lived in or visited the geographical area. Third, the interaction frequency data did not always follow a normal distribution. See Appendix G for frequency distributions of the interaction data. Finally, exploratory statistical analyses on the data were conducted and were selectively reported.

<u>(1) Do any significant differences in verbal interaction patterns occur between males and females in cooperative learning groups as they work with interactive multimedia when the gender composition of the groups is varied?</u>

A majority of the peer verbal interactions occurred when students were discussing the task (41.0%) and navigating the program (33.3%). The high percentage (74.3%) of peer interactions supporting accomplishment of the learning activities suggests that this type of interactive program helps keep students on task (Kinzie, 1990; Small & Grabowski, 1992). Students were on task when they made navigational decisions, responded to questions, and chose elements for their presentation. Off-task interactions comprised a small percentage (4.2%) of the total interactions, although this statistic may have been influenced by the presence of an observer.

Gender was not a significant factor in interaction patterns among students as they worked in cooperative groups with *Loess Hills Interactive*. This finding is not supported by Lee (1993) and Webb (1984) who found significant differences in verbal interaction patterns between males and females in groups of varying gender composition. Methodological differences between this investigation and the previous ones may account for the discrepancies. First, the scope of learning tasks in the present study was different from that in previous research. In this investigation students were involved in seeking and recording information to earn points for developing a presentation. In both Webb's and Lee's studies students were given well-defined tasks to be completed in one session. Students in Webb's investigation (1984) worked with pencil and paper on mathematical problems. In Lee's (1993) research, students used a computer-based problem-solving program, *Carmen San Diego*, which required students to discover clues related to mystery suspects within time constraints. Although students could chose from different interactive options in *Carmen San Diego*, they had to stay on the correct path to continue gathering information. In contrast, science students in this research watched video clips or pictures (investigation), answered questions (recall), and then developed a presentation (application). The tasks required by the *Loess Hills Interactive* program were a combination of well-defined (answering questions) and ill-defined (developing a project). Also, this study was conducted over a three-week period at the end of the school year. Gender differences which might have been apparent at the beginning of the year or during a short cooperative session may have become less important as students became comfortable working with each other (Peterson, Johnson, & Johnson, 1991). Both male and female students may have had time to develop positive relationships among group members over several sessions and thus felt less pressure to perform. The differences in learning activities and time constraints between the tasks in this and earlier studies may have lessened potential gender differences on verbal interactions and attitudes.

Gender differences in interaction frequencies might have been expected due to the scientific nature of the subject matter. Females tend to develop a bias against science by middle school (Dalton, 1990; Grossman & Grossman, 1994). The finding that females participated in group verbal interactions at the same frequencies as males may indicate that science-related learning activities presented in a multimedia format such as *Loess Hills Interactive* motivate both males and females. The innovative features of the program may have stimulated interest in students who otherwise would have had a low interest and participation levels. Also, the program contained elements which encouraged both cooperation and competition, perhaps extending appeal to both female and male students. The development of the presentation fostered cooperation whereas the earning of points became competitive among groups.

Equal-gender and mostly-male groups scored a higher number of interactions compared to mostly-female groups in total interaction frequencies. For task-related frequencies equal-gender and mostly-male groups had significantly more interactions than both mostly-female and same-gender groups. The fact that both types of group compositions, equal-gender and mostly-male, showed significantly higher interaction frequencies, parallels findings from previous investigations (Dillow, Flack & Peterman, 1994; Holden, 1993; Underwood, McCaffrey, & Underwood, 1990; Webb, 1984). Past research is not consistent regarding the effectiveness of equal-gender compared to mixed- and same-gender groups.

Further statistical analyses showed that students at School A scored significantly higher frequencies of total, path/pace, task, socio-emotional, and off-task verbal interactions than students at School B. This total number of interactions may be an indication of learning for ill-defined tasks (Cohen, 1994). Learning tasks for students working with the program included both well-defined (factual recall on questions) and ill-defined (development of a presentation) tasks. Variations in student populations, teacher support, and implemention of the program between the two schools may have influenced the significant differences in interaction frequencies and attitude. Students at School A were from a higher socioeconomic area than students at School B. It is also possible that previous experiences with cooperative learning were different for the two student samples. The School A teacher achieved a higher level of support of student work with the program than the two teachers at School B by: (a) maintaining visual supervision of groups through a window while working with the remaining students in an adjoining classroom, and (b) discussing scientific concepts from the program in the classroom. Implementation of the program also differed between the two schools. At School A, student use of the program was parallel to a classroom unit on ecosystems. When students worked with the program they were scheduled for 65 minutes each session. Workbooks were collected after each use and evaluated as part of the final grade. Students developed multimedia presentations for their parents using elements of the program. In contrast, the students at School B used the program in a workroom totally separate from their regular classrooms. Supervision was provided through a combination of school and research personnel. Sessions with the program were scheduled for 45 minutes. The subject matter from the program was not reinforced in students' regular classroom work, because the scheduled classwork for the four weeks did not parallel the program content. Students were not graded on their worksheets and they could not finish developing their presentations because of technical problems. The differences between schools suggest that possible student population differences, higher levels of teacher support, and factors of program implementation may affect frequencies of peer verbal interactions among students in cooperative learning groups.

(2) Do any significant differences in attitudes toward their cooperative learning experience occur between males and females using interactive multimedia when the gender composition of the groups is varied?

Both males and females had generally positive attitudes toward their learning experiences. None of the five attitudinal variables measured by the survey were significantly influenced by gender. However, one significant difference appeared with respect to gender grouping. The mostly-female groups showed a significantly higher preference for small-group learning, than other groups. If this finding is a reflection of a gender preference by females it seems reasonable to expect parallel findings in for the data for all-females groups. The fact that the data for all-female groups does not reflect a similar preference may be due to the following factors: (a) significant differences between males and females in same-gender groups may have occurred if a larger sample had been used, or (b) the dynamics in a mostly-female group foster a more positive attitude toward small-group learning than other groups. Previous research related to gender preference for cooperative learning is inconsistent (Dalton et al., 1989; Engelhard & Monsaas, 1989).

Further analyses using group composition and school as independent variables determined that students at School A responded significantly more favorably to their learning groups as measured by Factor 1, than those at School B. Variations in the level of teacher involvement with student use of the program might explain the more positive attitude by students at School A toward their groups. The teacher at School A was highly involved with making the use of the program successful, by maintaining supervision of the groups and talking about the program in the classroom. Another factor which might explain a more positive attitude toward their groups by students at School A was that those students were able to complete and give their multimedia presentations to parents. Possibly this accomplishment encouraged more positive attitudes toward group members. Finally, undocumented differences in cooperative experiences for students before the study occurred may have influenced their attitude toward their groups. Students at School A may have worked in groups more consistently throughout the year and have been more comfortable with each other. Students who work together frequently and have a highly motivated teacher may develop more positive attitudes with which to view new cooperative experiences.

(3) Are there any significant correlations between verbal interactions and attitudes toward the cooperative learning experience of males and females working with interactive multimedia?

Student interaction patterns and attitudes were not significantly associated with each other for students working with *Loess Hills Interactive*. Significant correlations appeared among interaction categories and among attitude categories but not between any specific interactions and attitudes. A more positive attitude was not associated with more frequent interactions. This suggests that frequency of student interactions were not dependent upon general attitude toward cooperative learning experience, emotional reaction to the group, the presence or lack of helping behaviors, or student preference or lack of preference for small-group learning. This further implies that even students who preferred to work alone or who didn't have a positive reaction to their group were sufficiently motivated to participate with other group members to a similar degree to those who preferred small-group learning.

Implications for Classroom Implementation of Cooperative Learning with Interactive Multimedia

The classroom teacher has control over many of the potential factors which may encourage peer verbal interaction and positive attitudes toward the cooperative learning experience for students working with interactive multimedia. First, a high level of support by the teacher may encourage students to participate in group interaction. Support may be indicated by a positive attitude, visual proximity without interference, or facilitation of classroom discussion about the subject matter and concepts presented by the program. Second, implementation of the program within the classroom may foster higher frequencies of peer interactions and more positive attitudes toward groupmates. Implementation factors include reinforcement of concepts and ideas between the program and regular classroom work and the use of grades. Another potentially effective factor was the student development and presentation of a group multimedia project.

Teachers and curriculum specialists need to view the use of technology as an integral part of the curriculum. What students learn using interactive technology may be maximized by factors such as teacher support and thoughtful implementation. Two considerations for technology coordinators are suggested. First, the importance of teacher training in understanding and using interactive multimedia in the classroom is noted. Using the technology for ungraded, stand-alone activities not directly tied to other curricular areas may undermine the educational potential of such programs. Second, the decision to locate technology work stations in labs may encourage classroom teachers to forgo making a commitment to high levels of involvement and support to their students when using technology.

Recommendations for Further Study

This study contributed additional findings to the research on the influence of gender and group gender composition on peer verbal interactions and attitudes or perceptions toward the cooperative learning group. Students used an interactive multimedia program designed for group work. The program was delivered by an innovative delivery platform, i-TV.

Research on how students interact among themselves needs to be conducted for differently structured cooperative tasks within the interactive multimedia environment. Cohen (1994) has suggested that successful interactions vary for ill-defined vs. well-defined learning tasks. Instructional designers need to be aware of what kinds of interactions they want to develop among students related to specific learning objectives. IRLE-type programs such as *Loess Hills Interactive* require successful decision-making interactions to navigate and access the information.

Further research should look at the effect of reward structure and task differentiation on interaction and attitude. The cooperative group structure may influence the functioning of the group. If group members were assigned roles, such as recorder or navigator, peer verbal interaction patterns may change. Normally quiet students may be encouraged to participate verbally if given a specific role. Also, the type of rewards given, whether they are group or individual, may affect levels of interaction and should be investigated.

Examination is needed of the differences in interactions between students who receive cooperative training and those who do not before they use multimedia. Research indicates that training in cooperative behaviors significantly improves the quality of cooperative group work for students (Dalton, 1990; King, 1989; Palincsar, Stevens & Gavelek, 1990). If students develop cooperative strategies prior to working with multimedia, they may benefit academically. Teachers should be aware of what kinds of training could significantly benefit cooperative learning experiences.

Further study should be done in the development of meaningful interaction scales for students using interactive multimedia. When using such programs, students are interacting not only among themselves but also with the technology. The complexity of the interaction process may require innovative methods of recording data. Scales that identify and distinguish types of interactions are needed for understanding interaction processes.

The students in this study used a program specifically designed for cooperative learning. It would be helpful to program developers to identify the features in interactive multimedia which are most effective in stimulating cooperative behaviors and attitudes. One specific issue to investigate might be what kinds of questions on-screen are most effective in encouraging interaction when students are working with interactive programs.

Finally, investigators may want to consider the effect of the relevance of the program subject matter on student participation and attitudes. *Loess Hills Interactive* was developed for Iowa school curricula. When students have a personal connection to the subject matter, through geographical proximity, their interaction patterns and attitudes may be influenced.

Summary

This study was an opportunity to examine gender and group gender composition on peer verbal interactions and attitudes of cooperatively grouped students using the interactive multimedia program, *Loess Hills Interactive,* which was designed for group work. Students from two Iowa schools were assigned to groups of three, four, or five with one of the following gender compositions: (a) same-gender, (b) mostly-male, (c) mostly-female, and (d) equal-gender. The dependent variables included seven interaction categories (total, path/pace, task, socio-emotional, technical, off-task, and uncodable) and five attitudinal factors (positive emotional reaction to the group, presence of helping behaviors in the group, preference for working alone, lack of helping behaviors in the group, and preference for small-group learning). While using the program students answered worksheet and on-screen questions and developed a multimedia presentation.

Student gender did not have a significant effect on either peer interactions or attitudes toward cooperative learning. Results for group composition suggested the effectiveness of equal-gender and mostly-male groups in fostering participation levels among students for total and task-related interactions. Also, students in mostly-female groups expressed a more positive preference for small-group learning than students in other groups.

Further analyses determined that students from School A scored significantly higher than those from School B on five interaction and one attitudinal categories: total, path/pace, task, socio-economic, off-task, and positive emotional reaction to their group. These findings suggest that differences between the student populations, teachers' levels of support, and implementation of the program were factors influencing student participation and attitudes. Students in School A were from a higher socioeconomic area. It is possible that they had experienced more cooperative learning activities in their classes previous to the study. The teacher at School A maintained a high level of support for students by visual supervision and discussion of program concepts in the classroom. Students at School A may also have benefited from longer scheduled sessions with the program, the accomplishment of creating a multimedia presentation for their parents, and the knowledge they were being graded on their work.

The significance of the differences between the schools suggests important implications for designing and using interactive multimedia effectively in the classroom. The importance of giving teachers strategies for using technology that reflect research findings should be noted. Educators and software developers need to be aware of factors which potentially increase the educational effectiveness of using interactive multimedia as an integral part of the curriculum.

APPENDIX A. STUDENT WORKSHEETS

GEOLOGY

1) What is the basic definition of loess?

2) In the space below, describe how the Loess Hills were formed:

3) List three reasons why the Loess Hills attract the attention of many scientists?

4) In which other country can we find hills with loess deposits as deep as the ones in the Iowa?

5) Who were the first humans known to inhabit the Loess Hills?

6) What are "kindchens"?

FAUNA

1) Why are some of the animal species of the Loess Hills facing extinction?

2) Why are some butterfly species dependent on the prairies to survive?

3) List three animal species which inhabit the woodlands of the Loess Hills:

4) List three animal species which inhabit the prairies of the Loess Hills:

5) List some of the endangered species which inhabit the desert-like regions of the Loess Hills:

6) Why can species that are only common to the western U.S. still survive in the Loess Hills?

ENVIRONMENT/PRESERVATION

1) What are the three natural ecosystems found in the Loess Hills?

2) Why do the prairies of the Loess Hills fascinate many biologists?

3) Why have natural wetlands almost disappeared from the Loess Hills?

4) Why does erosion occur so often in the Loess Hills?

5) What are some of the methods used to preserve prairies? (describe them)

6) How can prairies benefit from fire burns?

APPENDIX B. INTERACTION TALLY SHEET

Student Number_______ Gender _____ Group Number________

Segment ____ (___________ to____________)

Coder's Name__________________________

Verbal Interactions		**Totals**
Determining pathway and/or pace through program:		
Asking for information/help		
Giving info/suggestions/responses		
(Testing of hypothesis)		
Accomplishing the tasks:		
Asking for information/help		
Giving info/suggestions/responses		
(Testing of hypothesis)		
Socio-emotional:		
Encouraging group or individual		
Discouraging group or individual		
Responding to program/task, positively		
Responding to program/task, negatively		
Responding to program/task, general		
Joking/being silly, sarcastic		
Technical:		
Off-task:		
Uncodable:		
Total Interactions:		

APPENDIX C. GUIDELINES FOR RATERS

Guidelines for Raters

Directions.
Use the Definitions of Terms on Interaction Scale to code the behaviors of students in separate viewings of each videotape. Only verbal behaviors are to be coded. Nonverbal behaviors may be used to help interpret verbal behaviors when appropriate. Do not code coughs, yawns, or such noises.

Each student is to be coded separately for two ten-minute intervals. The intervals are the same for all students in a particular group. The student number is determined by counting from left to right. The farthest student on the left would be number 1. Make sure to match the group number on the sheets with the group number on the list of groups for each tape. There are usually four groups per tape.

For the first group, code student number 1, then 2, etc. For the second tape, do not begin with number 1 but begin with number 2 and then follow in order. For tape number 3, begin with student number 3, etc. Try to go through the 10 minute segments twice for each student if there is any question in your mind that you need to confirm the data. The most important thing is to make sure you are on the right group that matches the group number on the coding sheet.

Decision Rules
Use the following decision rules:

1. A student may verbalize two categories one after the other. For instance, the student may say, "This is stupid. Why don't we go look at the maps?" this would be categorized as first socio-emotional response (negative) to the program and then giving a suggestion (determining where to go next).

2. If a student's verbalization is interrupted by another student and then finished with the same thought, response, suggestion, etc. then the verbalization is coded only once.

3. If you cannot understand a verbalization after listening to it three times, then code it as uncodable.

4. If a verbalization seems ambiguous, look at the context in which it is made. If students are in the process of trying to decide where to go or exercising learner control as in fastforwarding or pausing a video, then the utterance will most likely be considered path-oriented (if it is not socio-emotional). If students are trying to accomplish a task (helping to answer on-screen or workbook questions, developing a project, or earning points) then the utterance will probably be task-related.

APPENDIX D. ATTITUDINAL SURVEY

My name is ____________________

Iowa Public Television

Loess Hills Interactive Student Survey

You have recently been working in small groups with an interactive multimedia program called *Loess Hills Interactive*. We would like to ask you for your opinion about the program and the group learning experience.

Section 1 Think about the Loess Hills program you have been using and respond to statements 1 through 23. Circle the number that best represents your views. Use the following scale:

1=strongly disagree 2=disagree 3=moderately disagree 4=moderately agree 5=agree 6=strongly agree

		SD	D	MD	MA	A	SA
1.	The Loess Hills program was interesting.	1	2	3	4	5	6
2.	The program made me more interested in science.	1	2	3	4	5	6
3.	The program helped me understand the importance of preserving the Loess Hills.	1	2	3	4	5	6
4.	The graphics and animations looked professional.	1	2	3	4	5	6
5.	The video segments looked professional.	1	2	3	4	5	6
6.	The Loess Hills program was easy to use.	1	2	3	4	5	6
7.	The remote control was easy to use.	1	2	3	4	5	6
8.	The icons (symbols) were easy to understand.	1	2	3	4	5	6
9.	The screens were easy to understand.	1	2	3	4	5	6
10.	The text on the screen was large enough and clear enough to read.	1	2	3	4	5	6
11.	The host, "Justin," helped me understand the program.	1	2	3	4	5	6
12.	The worksheets were helpful.	1	2	3	4	5	6
13.	There were enough video segments to choose from.	1	2	3	4	5	6
14.	The dictionaries were helpful.	1	2	3	4	5	6
15.	The video segments were too long.	1	2	3	4	5	6

		SD	D	MD	MA	A	SA
16.	The maps were helpful.	1	2	3	4	5	6
17.	Doing the project helped me learn more.	1	2	3	4	5	6
18.	The feedback after answering the questions was helpful.	1	2	3	4	5	6
19.	The library was a good way to organize and display options.	1	2	3	4	5	6
20.	I could find the information I needed in the program to answer the questions.	1	2	3	4	5	6
21.	The Loess Hills program was a worthwhile activity.	1	2	3	4	5	6
22.	Overall, I was satisfied with the Loess Hills program.	1	2	3	4	5	6
23.	The Loess Hills program was a good way to learn.	1	2	3	4	5	6

Section 2 In the previous section, we asked your opinion about the Loess Hills program. The Loess Hills program is an example of an interactive multimedia computer program. Now think about your experience with other programs similar to the Loess Hills program and respond to the following statements. Circle the number that best represents your views. Use the following scale:

1=strongly disagree 2=disagree 3=moderately disagree 4=moderately agree 5=agree 6=strongly agree

	When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...	SD	D	MD	MA	A	SA
24.	...I learn better.	1	2	3	4	5	6
25.	...I don't learn much because the lessons are so mixed up.	1	2	3	4	5	6
26.	...I think exploring and searching for information is a good way to learn.	1	2	3	4	5	6
27.	...I learn things better when I can see <u>and</u> hear them.	1	2	3	4	5	6
28.	...I think I can learn better from a videotape than from an interactive multimedia computer program.	1	2	3	4	5	6
29.	...I think it is a good way to learn.	1	2	3	4	5	6
30.	...I like to explore and search for information.	1	2	3	4	5	6
31.	...I think I learn as much as in a regular class.	1	2	3	4	5	6
32.	...I feel I have control of my own learning.	1	2	3	4	5	6
33.	...It is more interesting than regular classroom instruction.	1	2	3	4	5	6
34.	...I think I can learn better from books.	1	2	3	4	5	6

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

		SD	D	MD	MA	A	SA
35.	...I would rather learn in a different way.	1	2	3	4	5	6
36.	...The choice of text, video, photographs, drawings, and sound make learning more fun.	1	2	3	4	5	6
37.	...I like to set the pace of my own learning.	1	2	3	4	5	6
38.	...I'm not sure what I'm supposed to be learning.	1	2	3	4	5	6
39.	...I like it because I don't have to watch parts I don't want to watch.	1	2	3	4	5	6
40.	...I like it because it lets me learn on my own.	1	2	3	4	5	6
41.	...It is a waste of time because there is no clear purpose.	1	2	3	4	5	6
42.	...It lets me learn the way I learn best.	1	2	3	4	5	6
43.	...It is confusing.	1	2	3	4	5	6
44.	...I would like to try other interactive multimedia programs.	1	2	3	4	5	6
45.	...Exploring and searching for information is a waste of time.	1	2	3	4	5	6
46.	...It is a good way to learn because it does not have to be used the same way every time.	1	2	3	4	5	6
47.	...Choices between text,video, photographs, drawings, and sound are confusing.	1	2	3	4	5	6

Section 3 Now think about your experience working in your group with the Loess Hills program and answer the following questions. Circle the number that best represents your views. Use the following scale:

1=strongly disagree   2=disagree   3=moderately disagree   4=moderately agree   5=agree   6=strongly agree

		SD	D	MD	MA	A	SA
48.	Working in small groups makes learning fun.	1	2	3	4	5	6
49.	I usually prefer to work by myself.	1	2	3	4	5	6
50.	Working in small groups helps me learn better.	1	2	3	4	5	6
51.	I liked working with my group.	1	2	3	4	5	6
52.	I would have been more comfortable working alone.	1	2	3	4	5	6
53.	I would choose to work in this group again.	1	2	3	4	5	6

TURN PAGE>>

		SD	D	MD	MA	A	SA
54.	My group worked too slowly for me.	1	2	3	4	5	6
55.	Group members helped each other complete the lesson.	1	2	3	4	5	6
56.	My group learned a lot from the program.	1	2	3	4	5	6
57.	I could have accomplished more working alone.	1	2	3	4	5	6
58.	Everybody in my group got to participate.	1	2	3	4	5	6
59.	The group listened to everyone's ideas.	1	2	3	4	5	6
60.	Everyone in the group helped each other.	1	2	3	4	5	6
61.	My suggestions and explanations helped other group members with the lesson.	1	2	3	4	5	6
62.	I helped group members when they had questions about the lesson.	1	2	3	4	5	6
63.	I did not help answer questions in my group.	1	2	3	4	5	6
64.	I helped my group make decisions during the lesson.	1	2	3	4	5	6
65.	My group members were helpful to me.	1	2	3	4	5	6
66.	When I asked a question, my group members did not help me.	1	2	3	4	5	6
67.	Members of my group explained what I did not understand.	1	2	3	4	5	6

Section 4 Please circle the response that best describes how much you knew about the Loess Hills before you used the Loess Hills program.

1= Nothing 2= A little 3= A lot

Now, we'd like you tell us a little about yourself. Please mark the appropriate response.

I am male female

My ethnic origin is Caucasian Black American Asian/Pacific Islander

Hispanic Native American Other ___________

I am in grade 5 6 7 8 9

How many boys _____ and how many girls _____ were in your group (including yourself)?

APPENDIX E. PARENTAL PERMISSION LETTER

Iowa Public Television

April 2, 1996

Dear Parent,

In the next few weeks, your child's class will be participating in an evaluation of a newly-developed Iowa Public Television program, *Loess Hills Interactive*. This program contains information about the archeology, geology, and animals of the Loess Hills region of Iowa. We would like your child to participate in the evaluation of this program. Students will be working with the program during science class for about one month.

After completion of the program, students will complete written surveys to determine 1) how well they liked the program; 2) their preferred learning style; and 3) their attitudes toward the small group learning experience in which they participated. These surveys should take a total of 45 minutes. The results of these surveys will be used to evaluate the effectiveness of the *Loess Hills* program for use in the classroom.

In addition to the surveys, some children may be asked to participate in hour-long group interviews to discuss their reactions to the program. This interview may be recorded.

Classroom observations will be conducted in the classrooms to assess how children interact with the *Loess Hills* program and in the small group learning experience. These observations may be videotaped.

All data collected will be confidential. Only Iowa State University personnel involved in analyzing the data will have access to the surveys and other recorded information. Information will be reported only for a group of students; no individual students will be identified. All recorded data will be destroyed within one year of the project.

Participation in this evaluation is voluntary and will not affect your child's science grade. If you have any questions, please contact Charles Schlosser or Jane Adamson at:

Research Institute for Studies in Education
E005 Lagomarcino Hall
Iowa State University
Ames, IA 50011
(515) 294-7009
(515) 294-9284 (fax)

If after consideration you **do not want** your child to participate in this evaluation, please sign the enclosed form and return it to your child's teacher or mail or fax it directly to the Research Institute at the address above.

Sincerely,

Charles Schlosser

Charles Schlosser
Research Associate

I **do not want** my child to participate in the Iowa Public Television evaluation of the *Loess Hills Interactive* Program.

____
Name of student

________________________________ __________________
Signature of parent Date

APPENDIX F. HUMAN SUBJECTS FORM

Information for Review of Research Involving Human Subjects
Iowa State University
(Please type and use the attached instructions for completing this form)

1. Title of Project IPTV Loess Hills Interactive Television Project - Evaluation

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

Michael Simonson — 1/22/96 — [signature]
Typed Name of Principal Investigator — Date — Signature of Principal Investigator

C & I / RISE — E005 Lagomarcino Hall — 294-7009
Department — Campus Address — Campus Telephone

3. Signatures of other investigators — Date — Relationship to Principal Investigator

[signature] — 1-22-96 — Co-PI

RECEIVED JAN 23 1996 GRADUATE COLLEGE ISU

4. Principal Investigator(s) (check all that apply)
☒ Faculty ☐ Staff ☐ Graduate Student ☐ Undergraduate Student

5. Project (check all that apply)
☒ Research ☒ Thesis or dissertation ☐ Class project ☐ Independent Study (490, 590, Honors project)

6. Number of subjects (complete all that apply)
4 # Adults, non-students ___ # ISU student 100 # minors under 14 ___ other (explain)
___ # minors 14 - 17

7. Brief description of proposed research involving human subjects: (See instructions, Item 7. Use an additional page if needed.)

Problem: Examine the effectiveness of a distance-delivered interactive television instructional product about the Loess Hills in a middle school class setting.

Method: Participating schools were selected by Iowa Public Television and have agreed to be part of the study. Individual middle school teachers were contacted by IPTV and agreed to participate in pilot-testing the Loess Hills interactive television product. Four teachers are participating. These teachers and all students in their science classes will make up the respondednt group.

Data will be gathered by survey instruments, interviews, and observations (draft instruments are attached).

(Please do not send research, thesis, or dissertation proposals.)

8. Informed Consent:
☐ Signed informed consent will be obtained. (Attach a copy of your form.)
☒ Modified informed consent will be obtained. (See instructions, item 8.)
☐ Not applicable to this project.

See attached letters

9. Confidentiality of Data: Describe below the methods to be used to ensure the confidentiality of data obtained. (See instructions, item 9.)

Surveys: Names will be used only for matching data from separate instruments. Once surveys are matched, individual identifiers will be removed. Only the evaluators will have access to the matching information.

Interviews/observations: Individual names will not be recorded. Groups will be identified by school and type of group (i.e., all male, all female, mixed). Only the evaluators will have access to any recorded information. All records will be destroyed after one year.

10. What risks or discomfort will be part of the study? Will subjects in the research be placed at risk or incur discomfort? Describe any risks to the subjects and precautions that will be taken to minimize them. (The concept of risk goes beyond physical risk and includes risks to subjects' dignity and self-respect as well as psychological or emotional risk. See instructions, item 10.)

None

11. CHECK ALL of the following that apply to your research:

- ☐ A. Medical clearance necessary before subjects can participate
- ☐ B. Samples (Blood, tissue, etc.) from subjects
- ☐ C. Administration of substances (foods, drugs, etc.) to subjects
- ☐ D. Physical exercise or conditioning for subjects
- ☐ E. Deception of subjects
- ☒ F. Subjects under 14 years of age and/or ☐ Subjects 14 - 17 years of age
- ☐ G. Subjects in institutions (nursing homes, prisons, etc.)
- ☒ H. Research must be approved by another institution or agency (Attach letters of approval)

If you checked any of the items in 11, please complete the following in the space below (include any attachments):

Items A - D Describe the procedures and note the safety precautions being taken.

Item E Describe how subjects will be deceived; justify the deception; indicate the debriefing procedure, including the timing and information to be presented to subjects.

Item F For subjects under the age of 14, indicate how informed consent from parents or legally authorized representatives as well as from subjects will be obtained.

Items G & H Specify the agency or institution that must approve the project. If subjects in any outside agency or institution are involved, approval must be obtained prior to beginning the research, and the letter of approval should be filed.

F - Letters will be sent to parents asking for permission for their children to participate.
Teachers will read information to the students and notify them of their right not to participate (see attached letter and instructions for teachers)

H - IPTV has contracted for these evaluation services and has agreed to make some of the data available for use by ISU graduate students. Agreements with schools were made by IPTV (see attached letter).

Last Name of Principal Investigator Simonson

Checklist for Attachments and Time Schedule

The following are attached (please check):

12. [X] Letter or written statement to subjects indicating clearly:
    - a) purpose of the research
    - b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see Item 17)
    - c) an estimate of time needed for participation in the research and the place
    - d) if applicable, location of the research activity
    - e) how you will ensure confidentiality
    - f) in a longitudinal study, note when and how you will contact subjects later
    - g) participation is voluntary; nonparticipation will not affect evaluations of the subject

13. [X] Consent form (if applicable)

14. [X] Letter of approval for research from cooperating organizations or institutions (if applicable)

15. [X] Data-gathering instruments

16. Anticipated dates for contact with subjects:

First Contact	Last Contact
2/1/96	6/1/96
Month / Day / Year	Month / Day / Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

12/31/96
Month / Day / Year

18. Signature of Departmental Executive Officer — Date — Department or Administrative Unit

Michael Simonson 1/22/96 RISE

19. Decision of the University Human Subjects Review Committee:

X Project Approved ___ Project Not Approved ___ No Action Required

Patricia M. Keith — 1/25/96 — P M Keith
Name of Committee Chairperson — Date — Signature of Committee Chairperson

GC:1/90

APPENDIX G. FREQUENCY DISTRIBUTIONS OF INTERACTION DATA

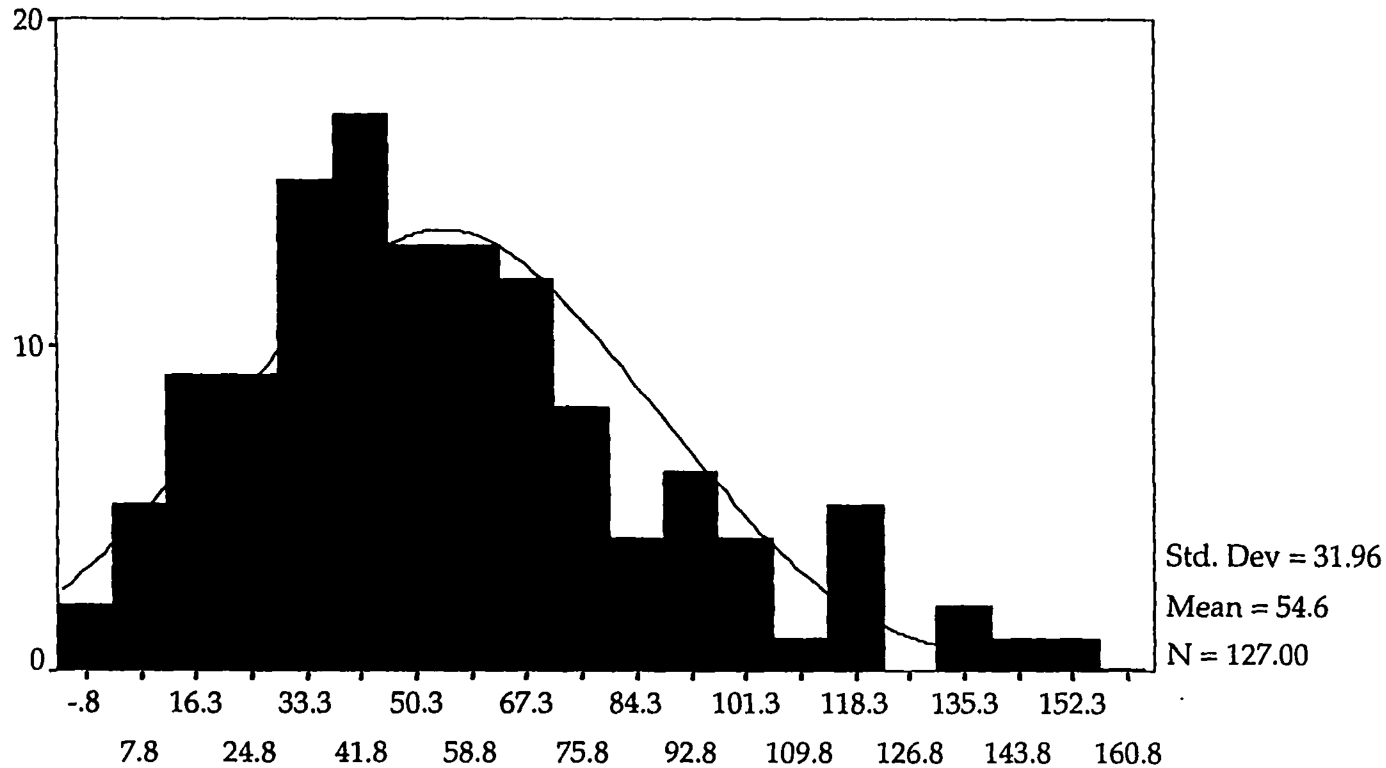

Figure G-1. Frequency distribution of total interactions

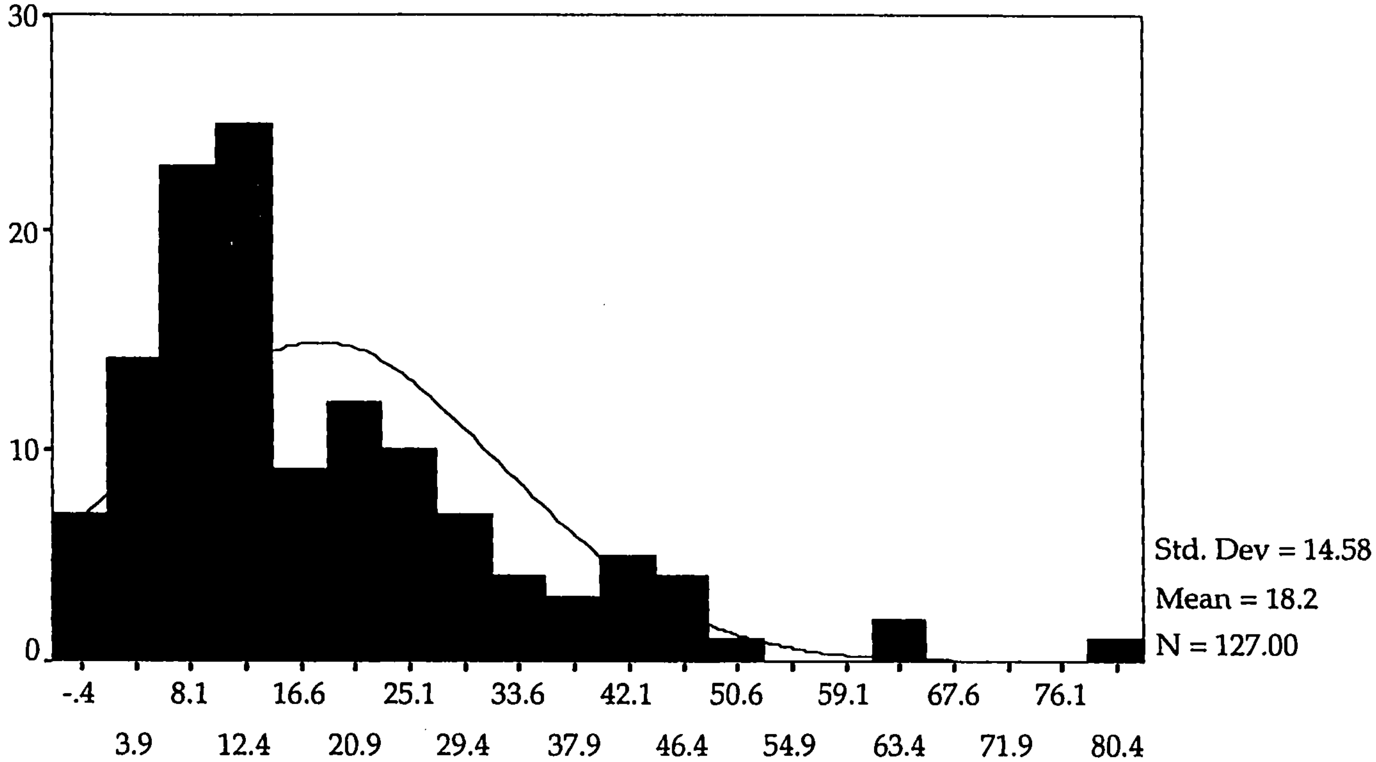

Figure G-2. Frequency distribution of path/pace interactions

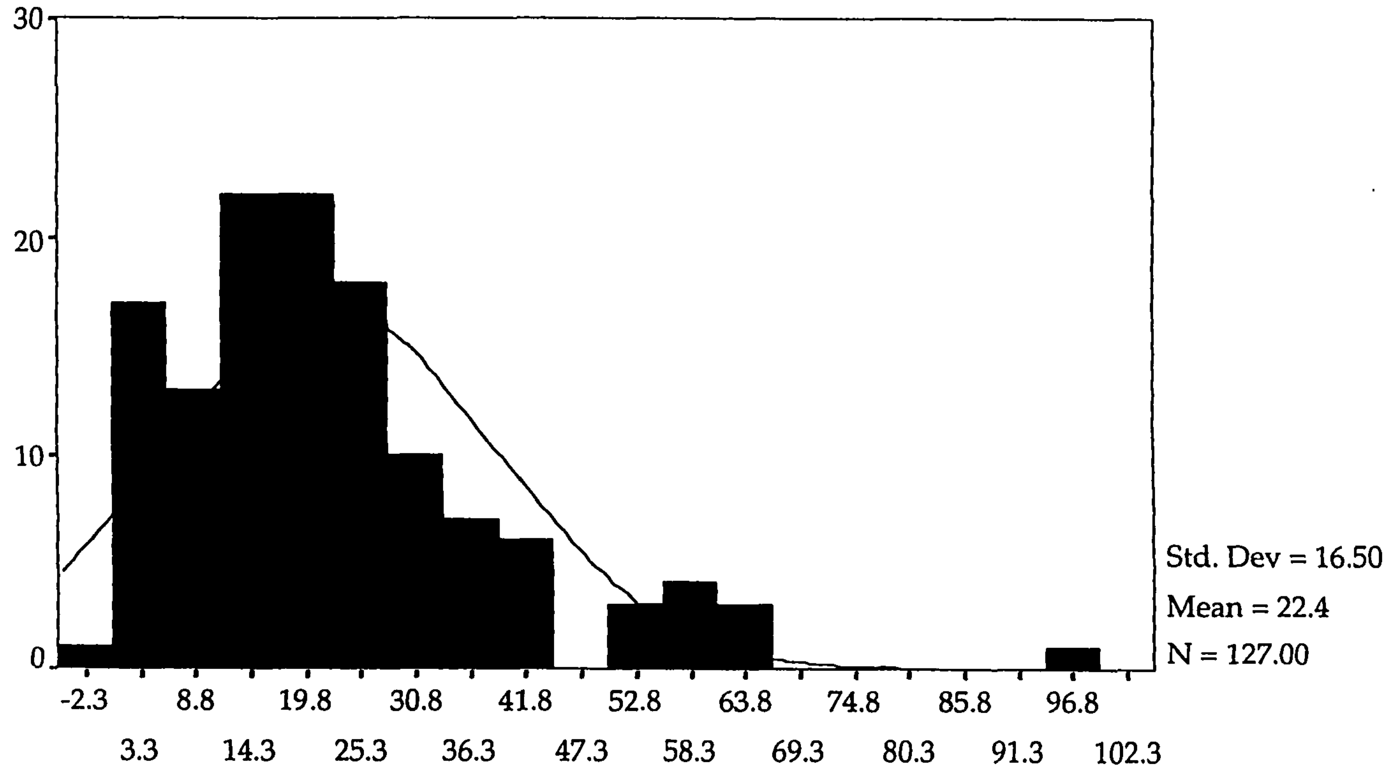

Figure G-3. Frequency distribution of task interactions

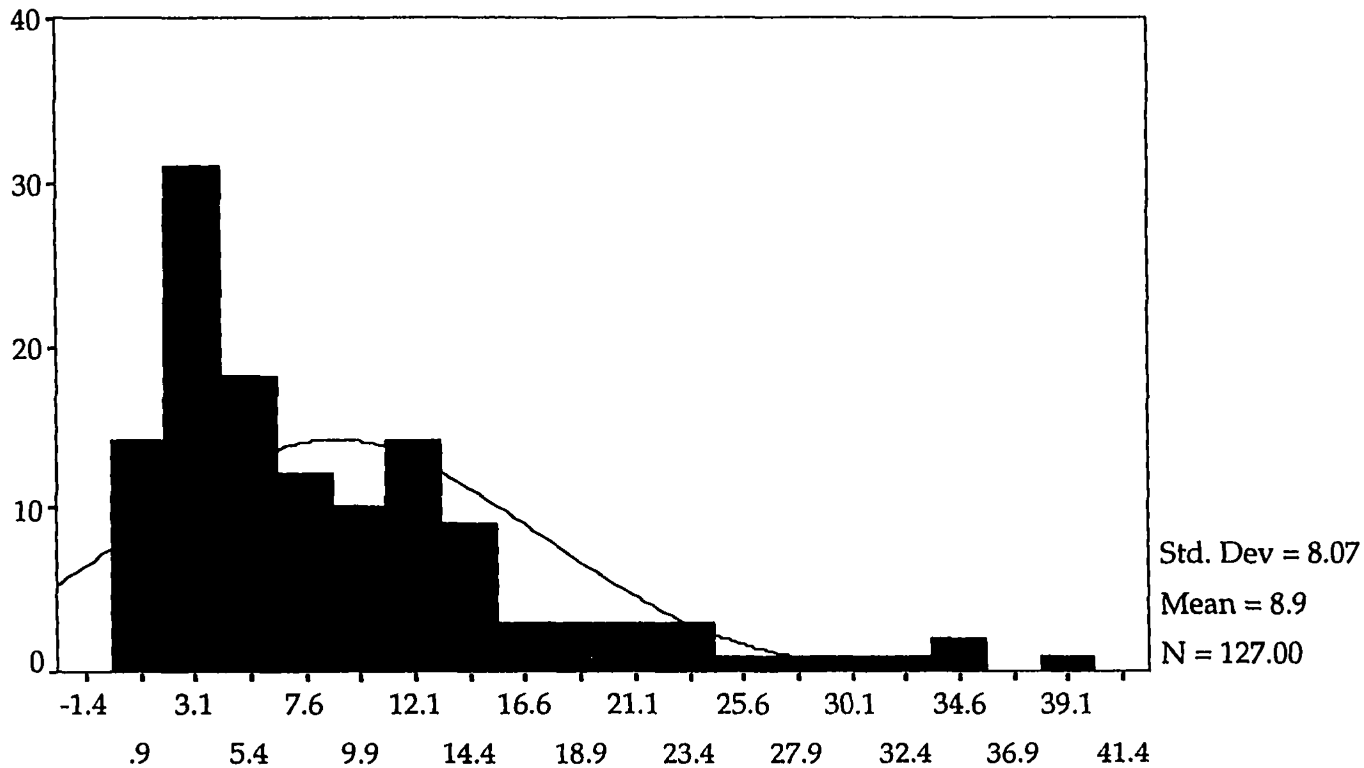

Figure G-4. Frequency distribution of socio-emotional interactions

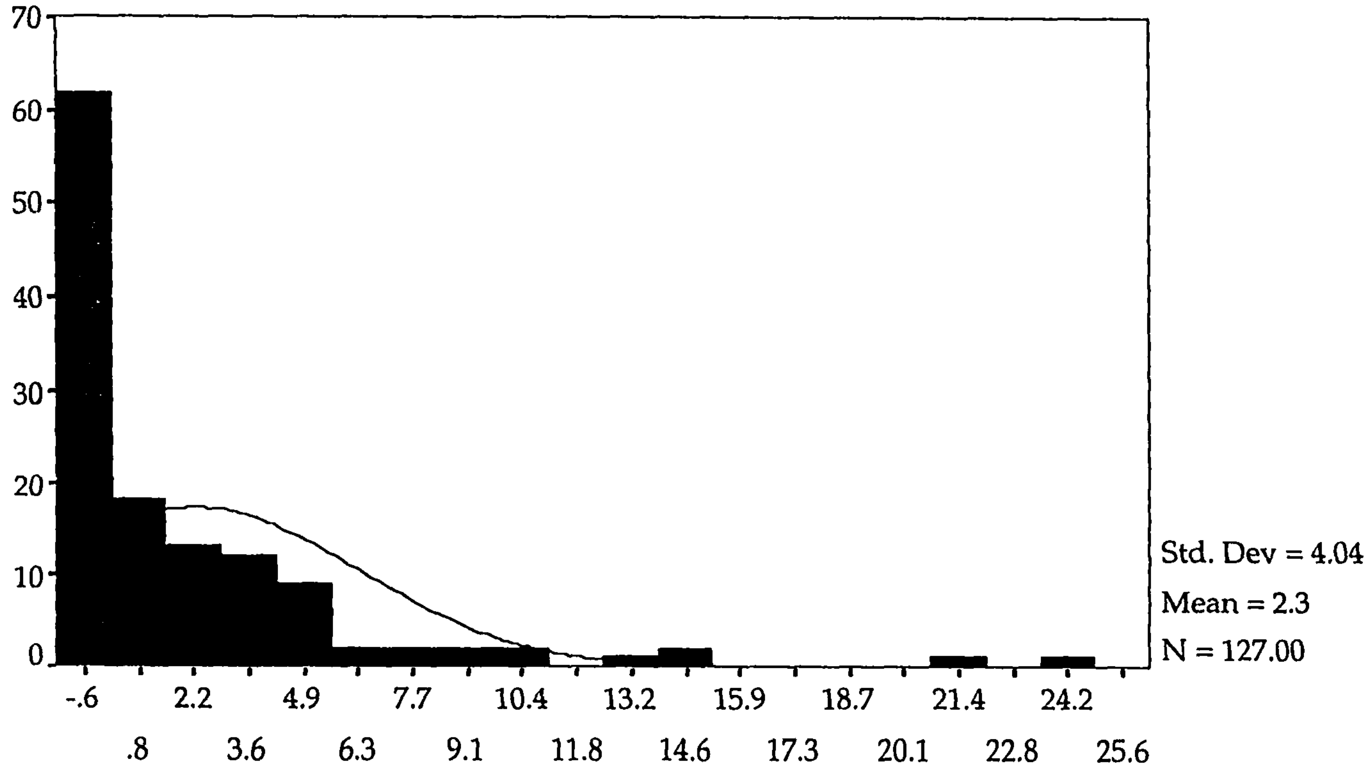

Figure G-5. Frequency distribution of offtask interactions

APPENDIX H. TWO-WAY INTERACTIONS

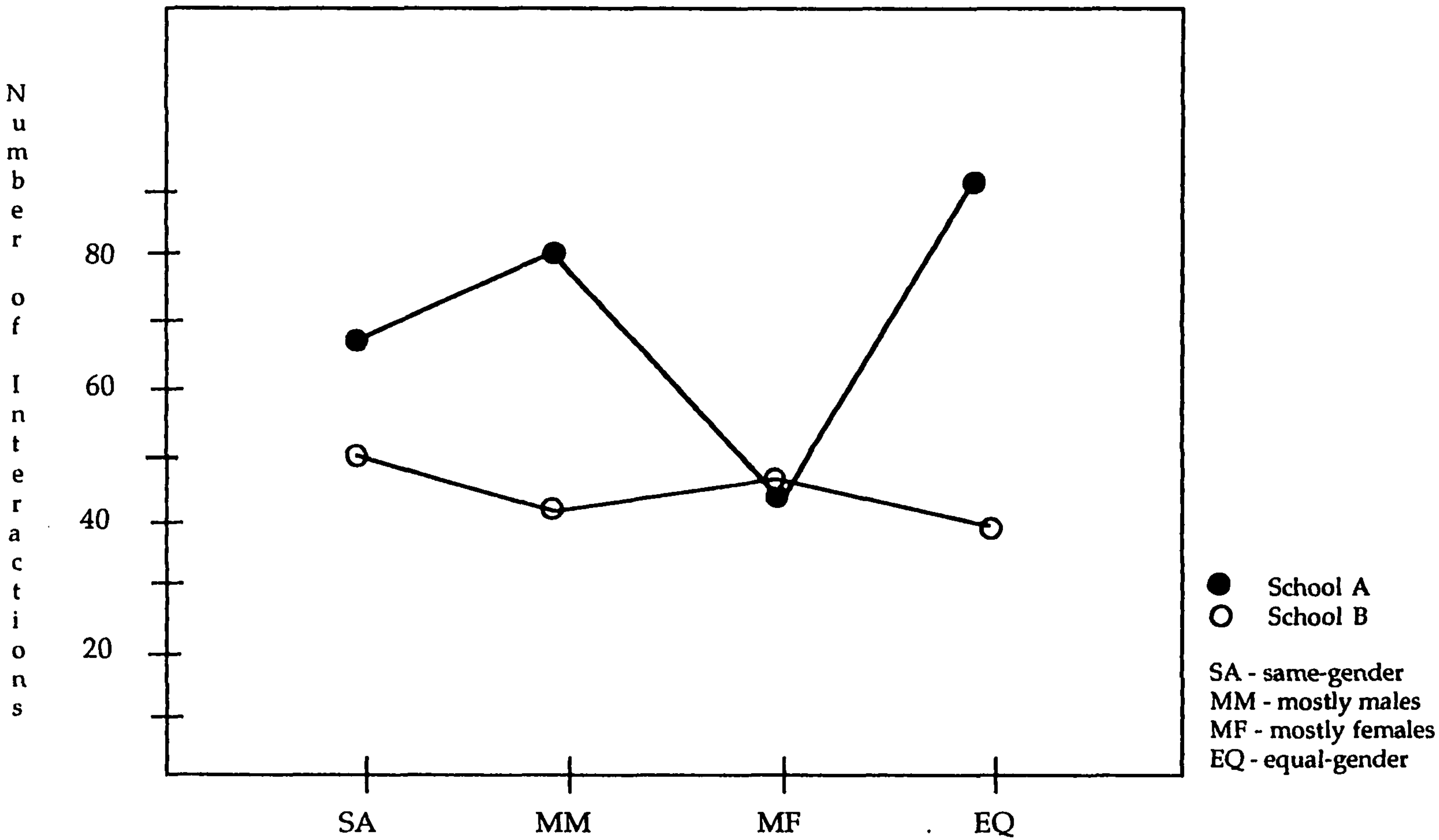

Figure H-1. Total interactions: Interactions between group composition and school.

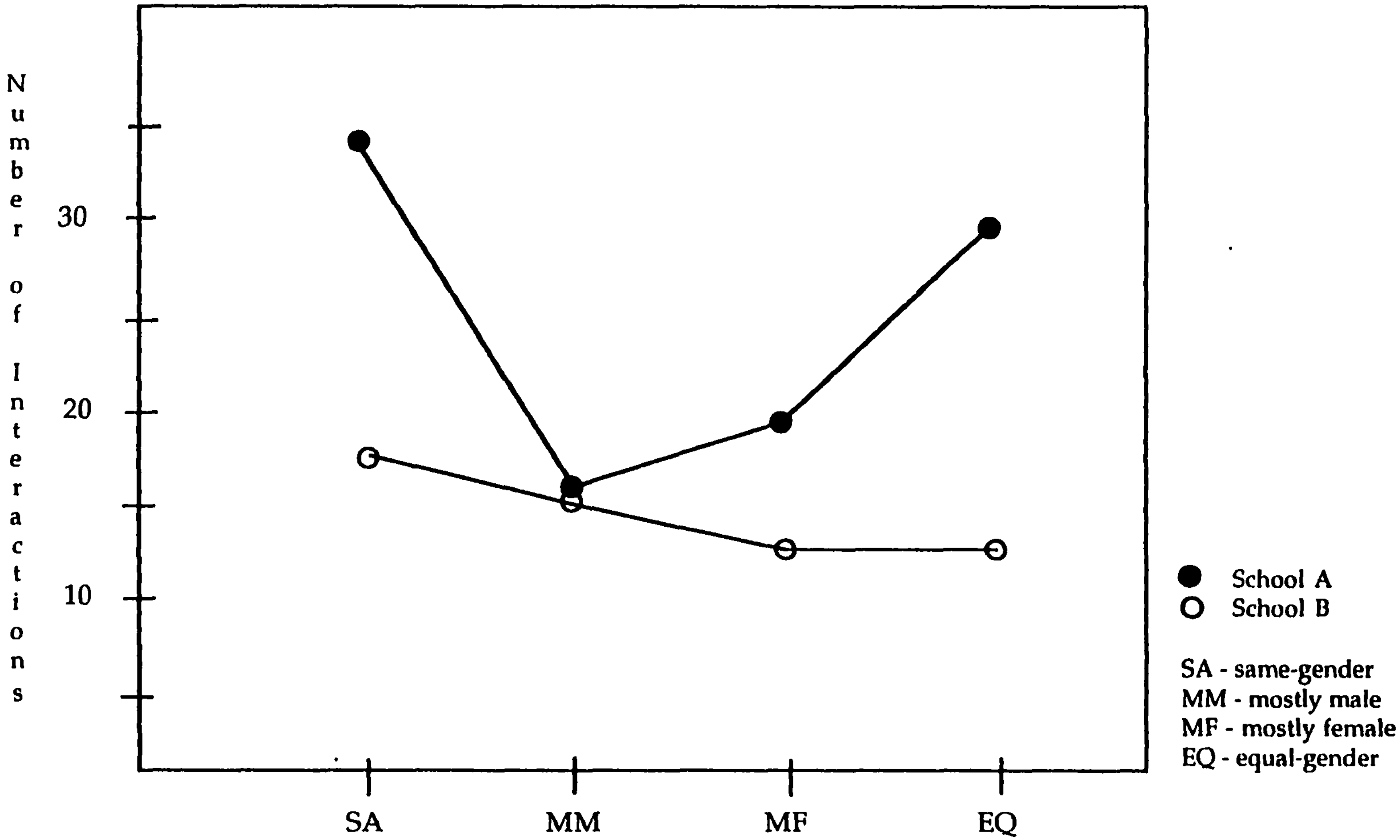

Figure H-2. Path/pace interactions: Interaction between group composition and school.

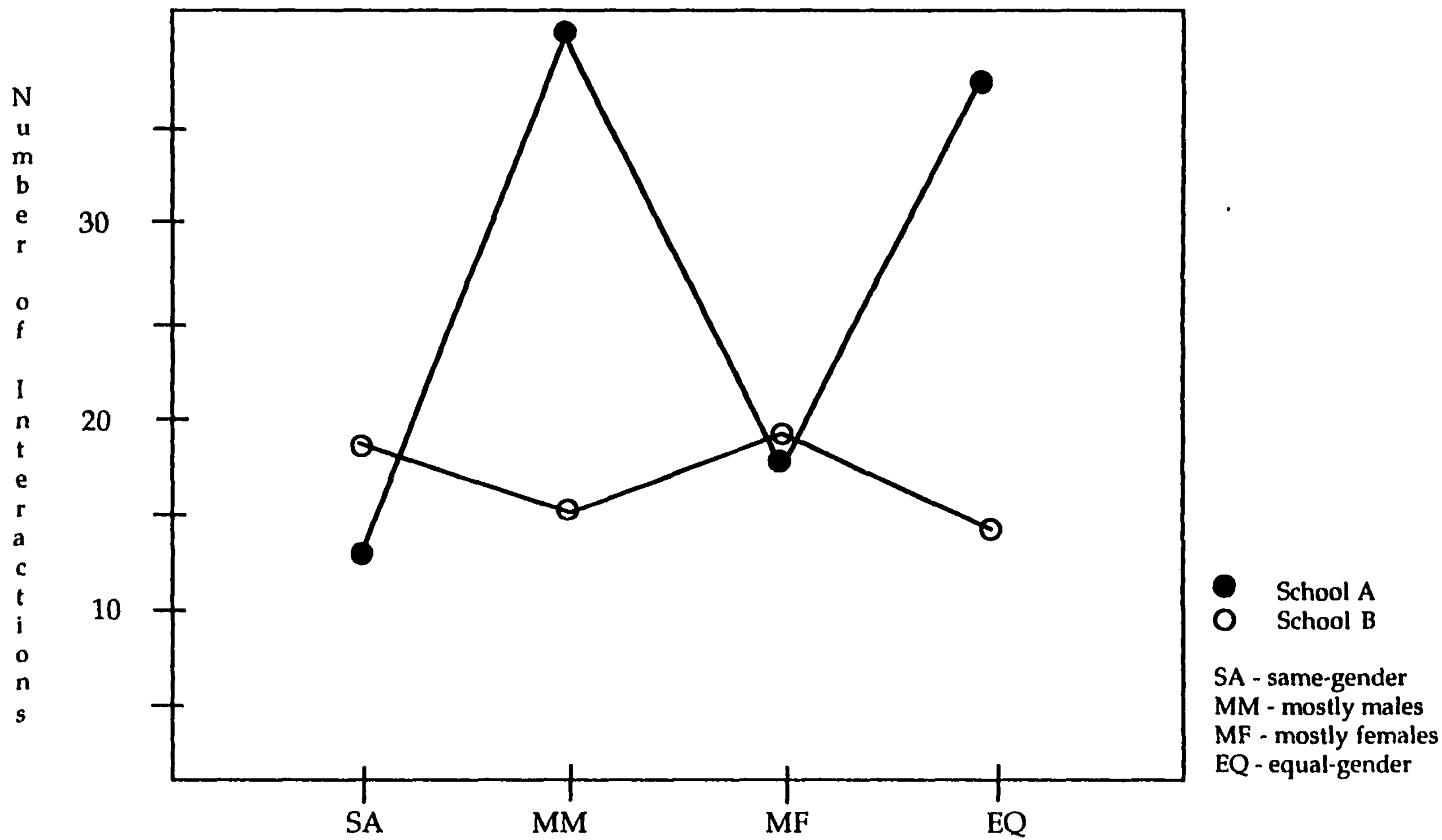

Figure H-3. Task interactions: Interaction between group composition and school.

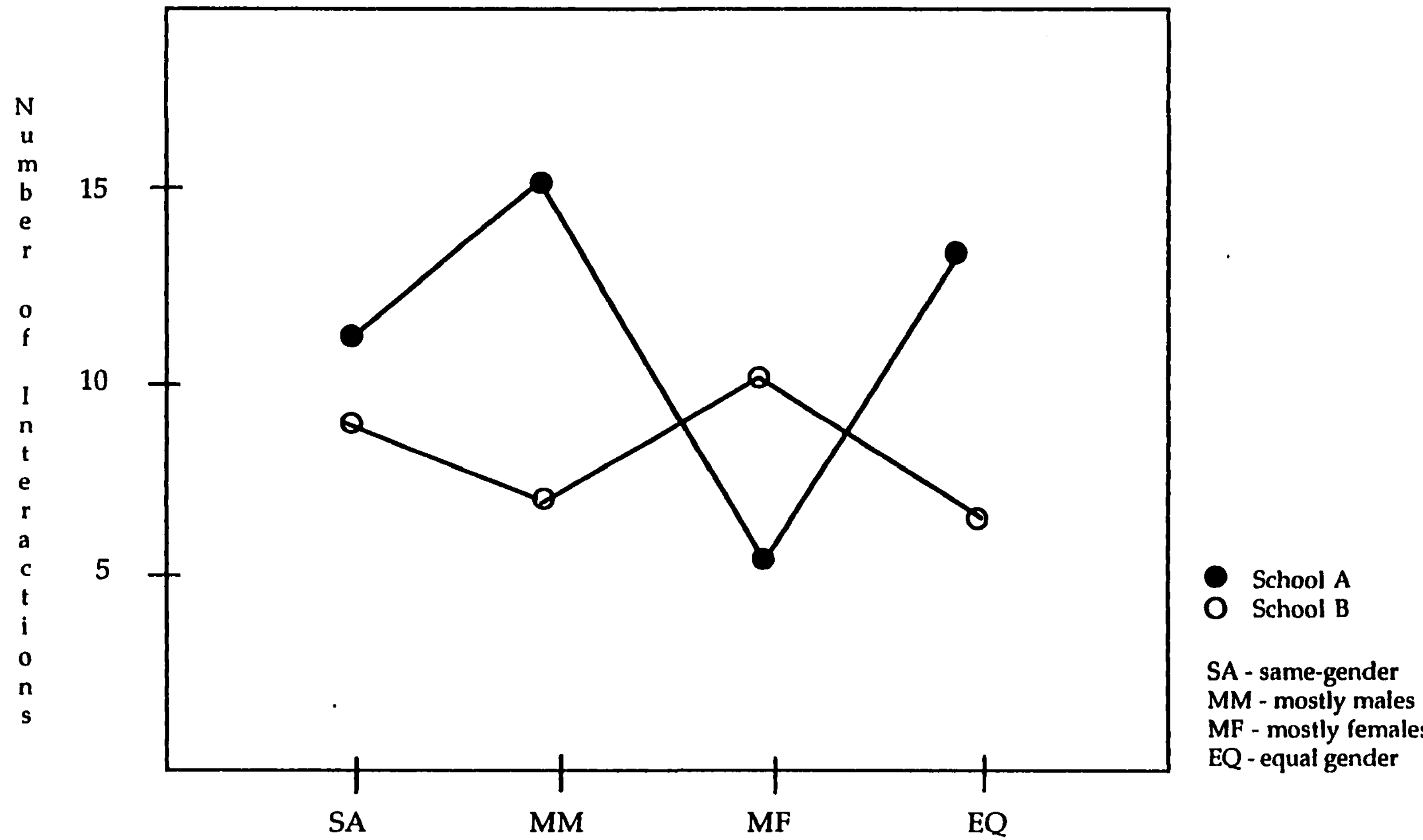

Figure H-4. Socio-emotional interactions: Interaction between group composition and school.

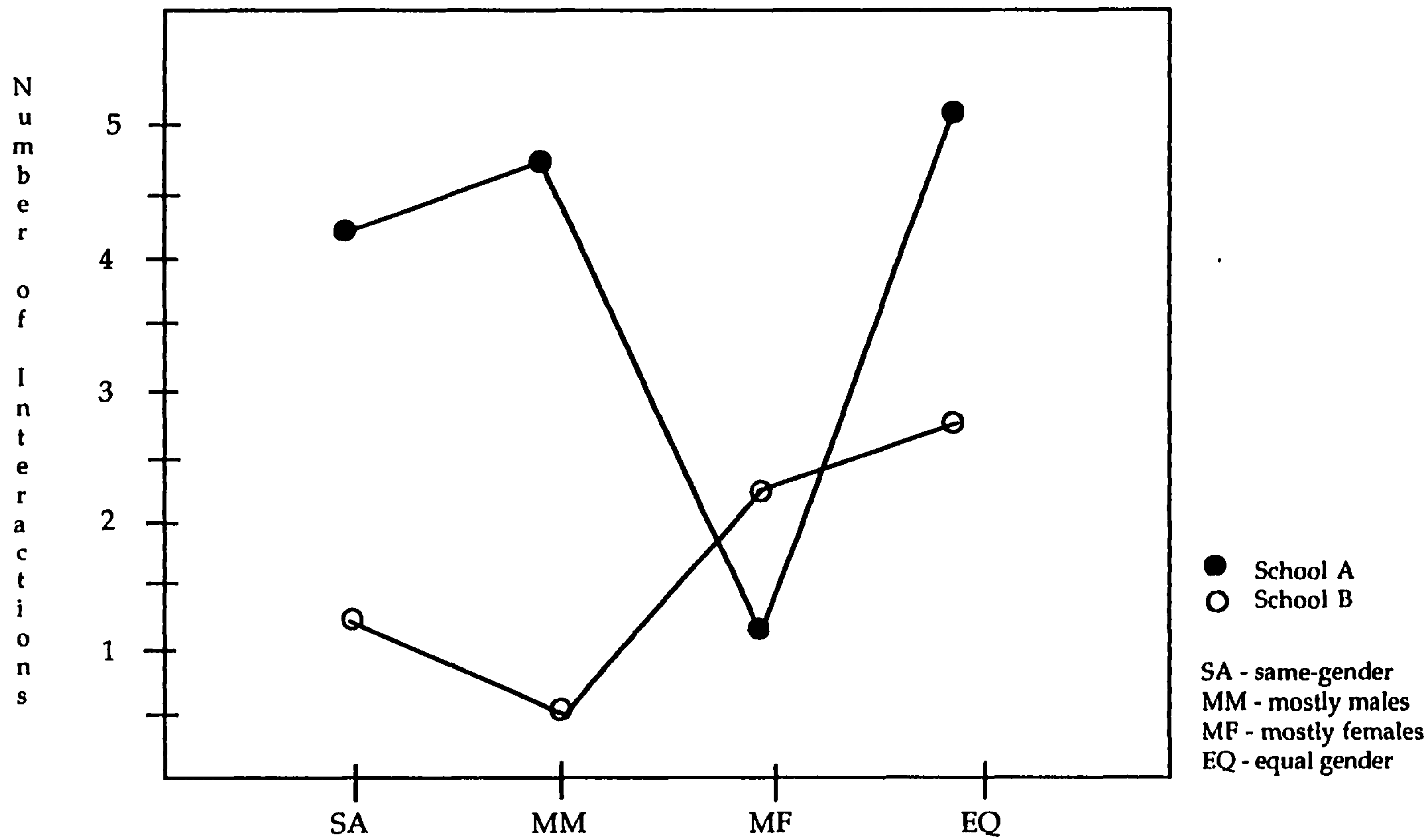

Figure H-5. Off-task interactions: Interaction between group composition and school.

BIBLIOGRAPHY

Adams, D., Carlson, H., & Hamm, M. (1990). Cooperative learning and educational media: Collaborating with technology and each other. Englewood Cliffs, NJ: Educational Technology Publications.

Adams, D. & Hamm, M. (1996). Cooperative learning: Critical thinking and collaboration across the curriculum. Springfield, IL: Charles C Thomas.

Adamson, J. M. (1997). Gender differences in peer interaction and attitudes: A pilot study. Unpublished manuscript, Iowa State University, Ames, IA.

Alberto, P. A. & Troutman, A. C. (1990). Applied behavior analysis for teachers. Columbus, OH: Merrill.

Alkin, M. C. (Ed.). (1992). Encyclopedia of educational research (6th ed.). New York: MacMillan.

Aronson, E., Blaney, N., Stephan, C., Sikes, J., & Snapp, N. (1978). The jigsaw classroom. Beverly Hills, CA: Sage Publications.

Bagley, C. & Hunter, B. (1992). Restructuring, constructivism, and technology: Forging a new relationship. Educational Technology, 32(7), 22-27.

Bailey, M. L. (1993). The effects of progressive levels of interactivity in an interactive video lesson on achievement, attitude and peer interaction (videodisc). (Doctoral dissertation, Kansas State University, 1992). Dissertation Abstracts International, 53, 3090A.

Bakeman, R. & Gottman, J. (1986). Observing interaction: An introduction to sequential analysis. Cambridge, England: Cambridge University Press.

Bales, R. F. (1950). Interaction process analysis. Cambridge, MA: Addison-Wesley Press.

Battistich, V., Solomon, D., & Delucchi, K. (1993). Interaction processes and student outcomes in cooperative learning groups. The Elementary School Journal, 94(1), 19-32.

Berliner, D. C. (1992). Redesigning classroom activities for the future. Educational Technology, 32(10), 7-13.

Borsook, T. K. (1991). Harnessing the power of interactivity for instruction. Proceedings of Selected Research Presentations at the Annual Convention of the Association for Educational Communications and Technology. (ED334 976).

Borsook, T. K. & Higginbotham-Wheat, N. (1991). Interactivity: What is it and what can it do for computer-based instruction? Educational Technology, 31(10), 11-17.

Borsook, T. K. & Higginbotham-Wheat, N. (1992, February). A psychology of hypermedia: A conceptual framework for R & D. Paper presented at the annual meeting of the Association for Educational Communications and Technology, Washington, DC.

Bossert, S. T. (1988/89). Cooperative activities in the classroom. Review of Research in Education, 15, 222-250.

Bouton, C. & Garth, R. Y. (Eds.). (1983). Learning in groups. San Francisco: Jossey-Bass.

Branson, R. K. (1990). Issues in the design of schooling: Changing the paradigm. Educational Technology, 30(4), 7-10.

Campoy, R. (1992). The role of technology in the school reform movement. Educational Technology, 32(8), 17-22.

Chung, J. (1991). Collaborative learning strategies: The design of instructional environments for the emerging new school. Educational Technology, 31(12), 15-22.

Chung, J. & Reigeluth, C. M. (1992). Instructional prescriptions for learner control. Educational Technology, 32(10), 14-20.

Clark, R. E. (1985). Confounding in educational computing research. Journal of Educational Computing Research. 1(2), 137-148.

Clark, R. E. (1989). Current progress and future directions for research in instructional technology. Educational Technology Research and Development, 37(1), 57-66.

Cognition and Technology Group at Vanderbilt. (1996). Looking at technology in context: A framework for understanding technology and education research. In D. C. Berliner & R. C. Calfree (Eds.). Handbook of educational psychology (pp. 807-840). New York: Macmillan Library Reference USA.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. Review of Educational Research, 64, 1-35.

Cooper, P. (1993). Paradigm shifts in designed instruction: From behaviorism to cognitivism to constructivism. Educational Technology, 35(5), 12-19.

Cronin, M. W. & Cronin, K. A. (1992). A critical analysis of the theoretic foundations of interactive video instruction. Journal of Computer-Based Instruction, 19(2), 37-41.

Dalton, D. W. (1986). The efficacy of computer-assisted video instruction on rule learning and attitudes. Journal of Computer-Based Instruction, 13(4), 122-125.

Dalton, D. W. (1990). The effects of cooperative learning strategies on achievement and attitudes during interactive video. Journal of Computer-Based Instruction, 17(1), 8-16.

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research and Development, 37(2), 15-24.

Davis, S. (1990). The Iowa educational telecommunications network. Educational Technology, 30(6), 48.

Dede, C. J. (1987). Empowering environments, hypermedia and microworlds. The Computing Teacher, 15(3), 20-24, 61.

Dede, C. J. (1989). The evolution of information technology: Implications for curriculum. Educational Leadership, 29(9), 23-26.

Dede, C. J. (1990). The evolution of distance learning: Technology-mediated interactive learning. Journal of Research on Computing in Education, 22, 247-264.

Dede, C. J. (1992). The future of multimedia: Bridging to virtual worlds. Educational Technology, 32(5), 54-62.

Dillow, K., Flack, M., & Peterman, F. (1994). Cooperative learning and the achievement of female students. Middle School Journal, 26(2), 48-51.

Duffy, T. M. & Jonassen, D. H. (Eds.). (1992). Constructivism and the technology of instruction: A conversation. Hillsdale, NJ: Lawrence Erlbaum.

Engelhard, G. & Monsaas, J. A. (1989). Academic performance, gender, and the cooperative attitudes of third, fifth, and seventh graders. Journal of Research and Development in Education, 22(2), 13-17.

Folse, D. W. (1995). Effects of instructional directions and grouping in an interactive video lesson on achievement, peer interaction, attitude, and completion time. (Doctoral dissertation, Kansas State University, 1994). Dissertation Abstracts International, 55, 2264A.

Forman, E. (1989). The role of peer interaction in the social construction of knowledge. International Journal of Educational Research, 13, 55-69.

Gayeski, D. M. (1992). Making sense of multimedia: Introduction to special issue. Educational Technology, 32(5), 9-13.

Goodrum, D. A., Dorsey, L. T., & Schwen, T. M. (1993). Defining and building an enriched learning and information environment. Educational Technology, 33(11), 10-20.

Grossman, H. & Grossman, S. H. (1994). Gender Issues in Education. Needham Heights, MA: Allyn and Bacon.

Guntermann, E. & Tovar, M. (1987). Collaborative problem-solving with Logo: Effects of group size and group composition. Journal of Educational Computing Research, 3, 313-334.

Hannafin, M. J. (1992). Emerging technologies, ISD, and learning environments: Critical perspectives. Educational Technology Research and Development, 40(1), 49-63.

Hawkins, J. & Collins, A. (1992). Design experiements for infusing technology into learning. Educational Technology, 32(9), 63-67.

Heinich, R., Molenda, M., & Russell, J. D. (1989). Instructional media and the new technologies of instruction (3rd ed). New York: Macmillan.

Henderson, R. W. & Landesman, E. M. (1993). The interactive videodisc system in the zone of proximal development: Academic motivation and learning outcomes in precalculus. Journal of Educational Computing Research, 9(1), 29-43.

Hertz-Lazarowitz, R. (1989). Internal dynamics of cooperative learning. International Journal of Educational Research, 13(1), 97-102.

Hertz-Lazarowitz, R. (1989). Cooperation and helping in the classroom: A contextual approach. International Journal of Educational Research, 13(1), 113-119).

Hill, S. & Hill, T. (1990). The collaborative classroom: A Guide to co-operative learning. Portsmouth, NH: Heinemann Educational Books.

Holden, C. (1993). Giving girls a chance: Patterns of talk in cooperative group work. Gender and Education, 5, 179-189.

Hooper, S. (1992a). Cooperative learning and computer-based instruction. Educational Technology Research and Development, 40(3), 21-38.

Hooper, S. (1992b). Effects of peer interaction during computer-based mathematics instruction. Journal of Educational Research, 85(3), 180-189.

Jaspers, F. (1991). Interactivity or instruction? A reaction to Merrill. Educational Technology, 31(3), 21-24.

Jernstedt, G. C. (1983). Computer enhanced collaborative learning: A new technology for education. Technological Horizons in Education Journal, 10(7), 96-101.

Johnson, D. W. & Johnson, R. T. (1985). The internal dynamics of cooperative learning groups. In R. Slavin, S. Sharan, S. Kagan, R. Hertz-Lazarowitz, C. Webb, & R. Schmuck (Eds.), Learning to cooperate (pp. 103-124). New York: Plenum Press.

Johnson, D. W. & Johnson, R. T. (1986). Computer-assisted cooperative learning. Educational Technology, 26(1), 12-18.

Johnson, D. W. & Johnson, R. T. (1989). Toward a cooperative effort: A response to Slavin. Educational Leadership, 46(7), 80-81.

Johnson, D. W. & Johnson, R. T. (1993). Cooperative learning and feedback in technology-based instruction. In J. V. Dempsey & G. C. Sales (Eds.), Interactive instruction and feedback (pp. 133-157). Englewood Cliffs, NJ: Educational Technology Publications.

Johnson, D. W. & Johnson, R. T. (1994). Learning together and alone: Cooperative, competitive, and individualistic learning (4th ed.). Needham Heights, MA: Allyn and Bacon.

Johnson, D. W. & Johnson, R. T. , and Anderson, D. (1983). Social interdependence and classroom climate. The Journal of Psychology, 114, 135-142.

Johnson, D. W., Johnson, R. T., & Stanne, M. B. (1986). Comparison of computer-assisted cooperative, competitive, and individualistic learning. American Educational Research Journal, 23, 382-392.

Johnson, D. W., Johnson, R. T., & Taylor, B. (1993). Impact of cooperative and individualistic learning on high-ability students' achievement, self-esteem, and social acceptance. The Journal of Social Psychology, 113, 839-844.

Johnson, D. W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin, 89, 47-62.

Joiner, R., Messer, D., Light, P., & Littleton, K. (1995). Peer interaction and peer presence in computer based problem solving: A research note. Cognition and Instruction, 13, 583-584.

Jonassen, D. H. (1985). Interactive lesson designs: A taxonomy. Educational Technology, 25(6), 7-17.

Kemp, J. E. (1991). A perspective on the changing role of the educational technologist. Educational Technology, 31(6), 13-18.

Keppel, G. & Zedeck, S. (1989). Data analysis for research designs: Analysis of variance and multiple regression/correlation approach. New York: W. H. Freeman.

King, A. (1989). Verbal interaction and problem-solving within computer-assisted cooperative groups. Journal of Educational Computing Research, 5(1), 1-15.

Kinzie, M. B. (1990). Requirements and benefits of effective interactive instruction: Learner control, self-regulation, and continuing motivation. Educational Technology, Research and Development, 38(1), 1-21.

Kozma, R. B. (1991). Learning with media. Review of Educational Research, 61(2), 179-211.

Kulik, J. A., Kulik, C.-L., & Bangert Drowns, R. L. (1985). Effectiveness of computer-based education in elementary schools. Computers in Human Behavior, 1, 59-74.

Larsen, R. E. (1992). Relationship of learning style to the effectiveness and acceptance of interactive video instruction. Journal of Computer-Based Instruction, 19(1), 17-21.

Lazarowitz, R., Hertz-Lazarowitz, R., & Baird, J. H. (1994). Learning science in a cooperative setting: Academic achievement and affective outcomes. Journal of Research in Science Teaching, 31, 1121-1131.

Lee, M. (1989). Peer interaction in computer-based cooperative small group learning: The role of gender. (Doctoral dissertation, University of Wisconsin-Madison, 1989). Dissertation Abstracts International.

Lee, M. (1993). Gender, group composition, and peer interaction in computer-based cooperative learning. Journal of Educational Computing Research, 9, 549-577.

Levin, S. R. (1991). The effects of interactive video enhanced earthquake lessons on achievement of seventh-grade earth science students. Journal of Computer-Based Instruction, 18(4), 125-129.

Light, P. H. & Mevarech, Z. R. (1992). Cooperative learning with computers: An introduction. Learning and Instruction, 2, 155-159.

Litchfield, B. C. (1993, April). Design factors in multimedia environments: Research findings and implications for instructional design. Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA.

Lucas, L. (1992). Interactivity: What is it and how do you use it? Journal of Educational Multimedia and Hypermedia, 1, 7-10.

Manning, M. L. (1993). Cultural and gender differences in young adolescents. Middle School Journal, 25(1), 13-17.

Maskit, D. & Hertz-Lazarowitz, R. (1986, April). Adults in cooperative learning: Effects of group size and group gender composition on group learning behaviors. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Matta, K. F. & Kern, G. M. (1989). A framework for research in computer-aided instruction: Challenges and opportunities. Computers and Education, 13(1), 77-84.

McAuliffe, T. J. & Dembo, M. H. (1994). Status rules of behavior in scenarios of peer learning. Journal of Educational Psychology, 86, 163-172.

McCombs, B. L. (1985). Instructor and group process roles in computer-based training. Educational Communication and Technology Journal, 33(3), 159-167.

McMillan, J. H. (Ed.) (1980). The social psychology of school learning. New York: Academic Press.

Meeker, B. F. & Weitzel-O'Neill, P. A. (1977). Sex roles and interpersonal behavior in task-oriented groups. American Sociological Review, 42(1), 91-105.

Melby, J. N., Conger, R. D., Book, R., Rueter, M., Lucy, L., Repinski, D., Ahrens, K., Black, D., Brown, D., Huck, S., Mutchler, L., Rogers, S., Ross, J., & Stavros, T. (1993). The Iowa family interaction rating scales (4th ed.). Unpublished manuscript. Center for Family Research in Rural Mental Health, Iowa State University, Ames, IA.

Merrill, M. D. (1991). Constructivism and instructional design. Educational Technology, 31(5), 45-53.

Mevarech, Z. R. & Light, P. H. (1992). Peer-based interaction at the computer: Looking backward, looking forward. Learning and Instruction, 2, 275-280.

Mevarech, Z. R., Silber, O., & Fine, D. (1991). Learning with computers in small groups: Cognitive and affective outcomes. Journal of Educational Computing Research, 7, 233-243.

Mevarech, Z. R., Stern, D., & Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. Journal of Educational Research, 80(3), 164-167.

National Council of Teachers of Mathematics, Commission of Standards for School Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: The National Council of Teachers of Mathematics, Inc.

National Research Council. (1989). Everybody counts. Washington, DC: National Academy Press.

Nelson, W. A. & Palumbo, D. B. (1992). Learning, instruction, and hypermedia. Journal of Educational Multimedia and Hypermedia, 1, 287-299.

Papert, S. (1980). Mindstorms children, computers, and powerful ideas. New York: Basic Books, Inc.

Parkhurst, P., Lovell, K., Sprafka, S., & Hodgins, M. (1992). Evaluation of videodisc modules: A mixed method approach. Proceedings of selected research and development presentations at the Convention of the American Educational Communications Technology. ED348014.

Perkins, D. N. (1992). Technology meets constructivism: Do they make a marriage? In T. M. Duffy & D. H. Jonassen (Eds.) Constructivism and the technology of instruction (pp. 45-55). Hillsdale, NJ: Lawrence Erlbaum.

Petersen, R. P., Johnson, D. W., & Johnson, R. T. (1991). Effects of cooperative learning on perceived status of male and female pupils. The Journal of Social Psychology, 131, 717-755.

Pozzi, S., Healy, L., & Hoyles, C. (1993). Learning and interaction in groups with computers: When do ability and gender matter? Social Development, 2, 222-214.

Reeves, T. (1993). Evaluating interactive media. In D. Gayeski (Ed.), Multimedia for learning: Development, application, evaluation (pp. 97-112). Englewood Cliffs, NJ: Educational Technology Publications.

Repman, J. (1993). Collaborative, computer-based learning: Cognitive and affective outcomes. Journal of Educational Computing Research, 9(2), 149-163.

Resnick, L. B. (1989). Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser. Hillsdale, NJ: Lawrence Erlbaum.

Riel, M. (1989). The impact of computers in the classroom. Journal of Research on Computing in Education, 22, 180-190.

Roblyer, M. D. (1988). The effectiveness of microcomputers in education: A review of the research from 1980-1987. Technological Horizons in Education Journal, 16(2), 85-89.

Ross, S. M. & Morrison, G. R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. Educational Technology Research and Development, 37(1), 19-33.

Rysavy, S. D. & Sales, G. C. (1991). Cooperative learning in computer-based instruction. Educational Technology Research and Development, 39(2), 70-79.

Salomon, G. & Globerson, T. (1989). When teams do not function the way they ought to. International Journal of Educational Research, 13, 89-99.

Schlosser, C. & Adamson, J. (1996, November). *Loess Hills Interactive* evaluation report. (Available from Technology Research and Evaluation Group, College of Education, Iowa State University, Ames, IA 50011).

Schmuck, R. A. & Schmuck, P. A. (1975). Group processes in the classroom (2nd ed.). Dubuque, IA: Wm. C. Brown.

Schweir, R. (1989). Interactive video. Englewood Cliffs, NJ: Educational Technology Publications.

Schweir, R. A. (1992, June). A taxonomy of interaction for instructional multimedia. Paper presented at the annual conference of the Association for Media and Technology in Education in Canada, Vancouver, BC.

Schwen, T. M., Goodrum, D. A., & Dorsey, L. T. (1993). On the design of an enriched learning and information environment (ELIE). Educational Technology, 33(11), 5-9.

Seal-Wanner, C. (1988). Interactive video systems: Their promise and educational protential. Teachers College Record, 89, 373-83.

Seels, B. (1989). The instructional design movement in educational technology. Educational Technology, 29(5), 11-15.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. Review of Educational Research, 50, 241-271.

Sharan, S. (1990). Cooperative learning: A perspective on research and practice. in S. Sharan (Ed.) Cooperative learning: Theory and research. New York: Praeger.

Sharan, Y. & Sharan, S. (1992). Group investigation expands cooperative learning. Educational Leadership, 47(4), 17-21.

Shore, A. (1993, April). Interactive multimedia and student assessment. Paper presented at annual meeting of American Educational Research Association, Atlanta, GA.

Signer, B. R. (1992). A model of cooperative learning with intergroup competition and findings when applied to an interactive video reading program. Journal of Research on Computing in Education, 25(2), 141-158.

Simsek, A. (1992). The impact of cooperative group composition on student performance and attitudes during interactive videodisc instruction. Proceedings of Selected Research an Development Presentations at the Convention of the Association for Educational Communications and Technology and Sponsored by the Research and Theory Division. ED 348025.

Simsek, A. (1993). The effects of learner control and group composition on student performance, interaction, and attitudes during computer-based cooperative learning. (Doctoral dissertation, University of Minnesota, 1993). Dissertation Abstracts International, 54, 1223A.

Simsek, A. & Hooper, S. (1992). The effects of cooperative versus individual videodisc learning on student performance and attitudes. International Journal of Instructional Media, 19, 209-218.

Skon, L., Johnson, D. W., & Johnson, R. T. (1981). Cooperative peer interaction versus individual competition and individualistic efforts: Effects on the acquisition of cognitive reasoning strategies. Journal of Educational Psychology, 73(1), 83-92.

Slavin, R. E. (1980). Cooperative learning. Review of Educational Research, 50, 315-342.

Slavin, R. E. (1988). Cooperative learning and student achievement. Educational Leadership, 46(2), 31-33.

Slavin, R. E. (1989/90). Research on cooperative learning: Consensus and controversy. Educational Leadership, 47(4), 52-54.

Slavin, R. E. (1991). Student team learning: A practical guide to cooperative learning (3rd ed.). Washington, DC: National Education Association of the U.S.

Slavin, R. E. (1995). Cooperative learning: Theory, research, and practice (2nd ed.). Needham Heights, MA: Allyn & Bacon.

Slavin, R., Sharan, S., Kagan, S., Hertz-Lazarowitz, R., Webb, C., & Schmuck, R. (Eds.) (1985). Learing to cooperate, cooperating to learn. New York: Plenum Press.

Small, R. V. & Grabowski, B. L. (1992). An exploratory study of information-seeking behaviors and learning with hypermedia information systems. Journal of Educational Multimedia and Hypermedia, 1, 445-464.

Snow, R. E., Corno, L. & Jackson, D. (1996). Individual differences in affective and cognative functions. In D. C. Berliner & R. C. Calfree (Eds.) Handbook of educational psychology (pp. 243-310). New York: Macmillan Library Reference USA.

Stubbe, M. (1994). What's the score: Qualitative analysis in gender research. International Journal of Applied Linguistics, 4(1), 3-18.

Thompson, A. D., Simonson, M. R., & Hargrave, C. P. (1992). Educational technology A review of the research. Association for Educational Communications and Technology: Washington, DC.

Thompson, J. G. & Jorgensen, S. (1989). How interactive IS instructional technology? Alternating models for looking at interactions between learners and media. Educational Technology, 29(2), 24-26.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). Cooperative learning A guide to research. New York: Garland Publishing.

Tovar, M. & Coldevin, G. (1992). Effects of orienting activities and instructional control on learning facts and procedures from interactive video. Journal of Educational Computing Research, 8, 507-519.

Turner, S. V. & Dipinto, V. M. (1992). Students as hypermedia authors: Themes emerging from a qualitative study. Journal of Research on Computing in Education, 25, 187-199.

Underwood, G., McCaffrey, M., & Underwood, J. (1990). Gender differences in a cooperative computer-based language task. Educational Research, 32(1), 44-49.

U. S. Congress, Office of Technology Assessment. (1988). Power on! New tools for teaching and learning. Government Printing Office: Washington, DC.

University of Notre Dame. (1994). Changing the process of teaching and learning essays by Notre Dame faculty. University of Notre Dame: Educational Media.

Warring, D., Johnson, D. W., Maruyama, G., & Johnson, R. (1985). Impact of different types of cooperative learning on cross-ethnic and cross-sex relationships. Journal of Educational Psychology, 77, 53-59.

Webb, N. M. (1982a). Peer interaction and learning in cooperative small groups. Journal of Educational Psychology, 74, 642-656.

Webb, N. M. (1982b). Student interaction and learning in small groups. Review of Educational Research, 52, 421-445.

Webb, N. M. (1983). Predicting learning from student interaction: Defining the interaction variables. Educational Psychologist, 18(1), 33-41.

Webb, N. M. (1984). Sex differences in interaction and achievement in cooperative small groups. Journal of Educational Psychology, 76, 33-44.

Webb, N. M. (1985). Verbal interaction and learning in peer-directed groups. Theory into Practice, 24(1), 32-39.

Webb, N. M. (1989). Peer interaction and learning in small groups. International Journal of Education Research, 13, 21-39.

Webb, N. M. (1991). Task-related verbal interaction and mathematics learning in small groups. Journal for Research in Mathematics Education, 22, 366-389.

Webb, N. (1992). Collaborative group versus individual assessment in mathematics: Group processes and outcomes. Washington, DC: Office of Educational Research and Improvement (ED). ED353299.

Webb, N. M. (1993). Group collaboration assessment: competing objectives, processes ,and outcomes. Los Angeles, CA: National Center for Research on Evaluation, Standards, and Student Testing.

Webb, N. M. & Cullian, L. K. (1983). Group interaction and achievement in small groups: Stability over time. American Educational Research Journal, 20, 411-423.

Webb, N. M. & Palincsar, A. S. (1996). Group processes in the classroom. In D. C. Berliner, & R. C. Calfree (Eds.), Handbook of educational psychology (pp. 841-873). New York: Macmillan Library Reference USA.

Webb, N. M., Troper, J. D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. Journal of Educational Psychology, 87, 406-423.

Weller, H. G. (1988). Interactivity in microcomputer-based instruction: Its essential components and how it can be enhanced. Educational Technology, 28(2), 23-27.

Wiburg, K. (1994). Teaching science with technology: Telecommunications and multimedia. The Computing Teacher, 21(7), 4-8.

Wilkinson, L. C. & Marrett, C. B. (Eds.). (1985). Gender influences in classroom interaction. Orlando, FL: Academic Press.

Yacci, M. (1994). A grounded theory of student choice in information-rich learning environments. Journal of Educational Multimedia and Hypermedia, 3, 327-350.

Yager, S., Johnson, D. W., & Johnson, R. T. (1985). Oral discussion, group to individual transfer, and achievement in cooperative learning groups. Journal of Educational Psychology, 77(1), 60-66.